Interventional Treatment for Headaches

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***National PI/Steering Committees*:** StrokeNET DSMB, EMBOLISE, SUCCESS, SBIR/STTN, ETTN Study section, RapidPulse

Headache ….

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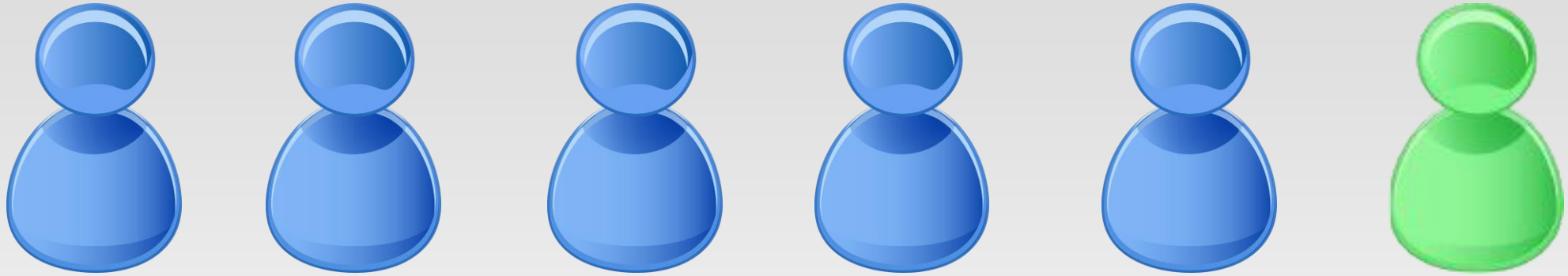
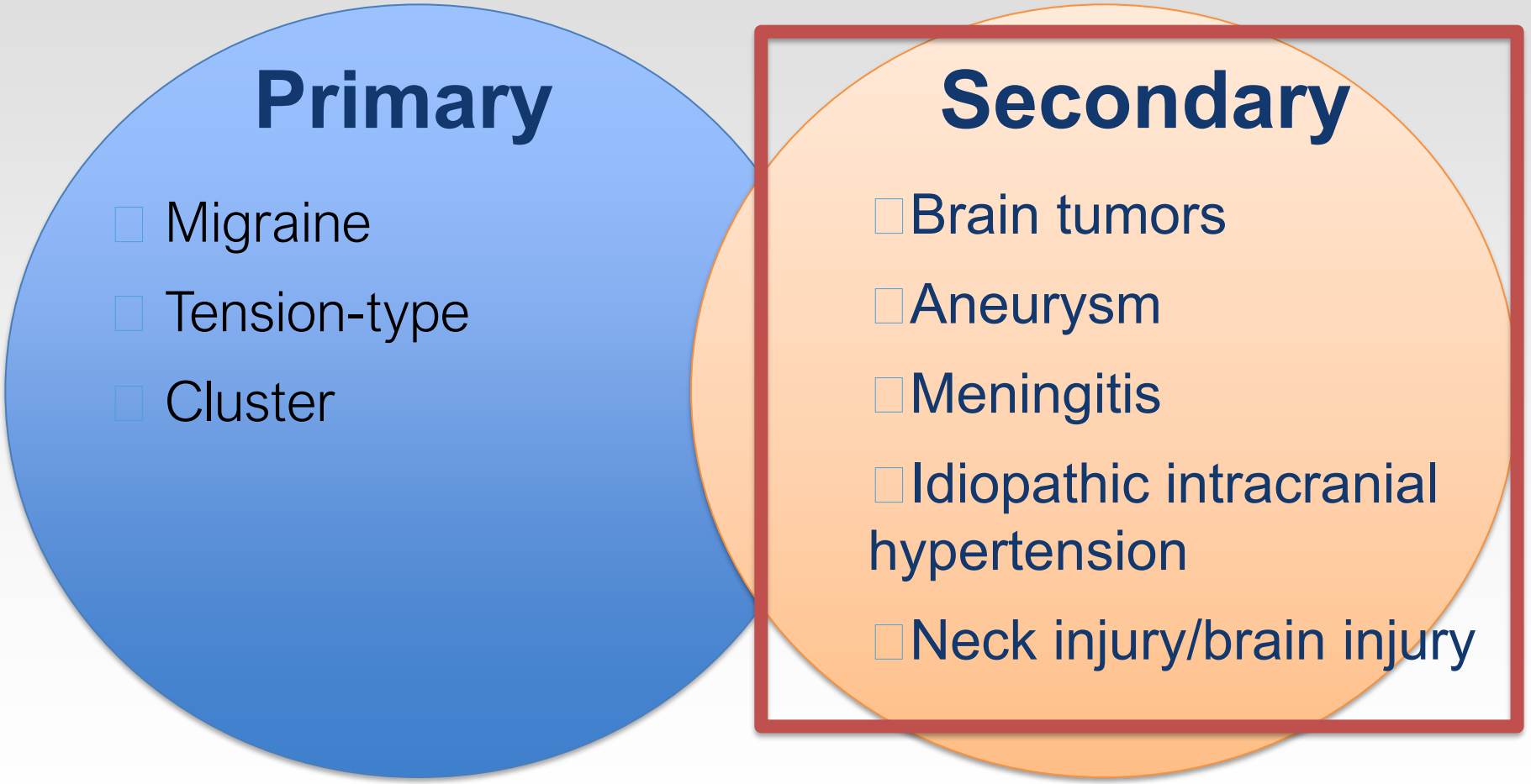
Severe headaches affect 1 in every 6 American



- Severe headaches affect 1 out of every 6 American and 1 in 5 women over 3 month period
- 4^{th} to 5^{th} most common reason for visits to ED (3% ED visits annually)
- Reproductive aged women – 3^{rd} leading cause for ED visit

When do we start working up headaches?



RED FLAGS!

- Sudden onset
- Onset after 50yo
- Increased frequency/severity
- New onset with underlying medical condition
- Focal neurologic signs/symptoms
- Papilledema/vision changes
- History of head trauma

Non contrast head CT may not show all differentials for headaches

Vascular

- Aneurysms/Subarachnoid hemorrhage
- AVM
- Carotid/vertebral dissection
- Stroke
- Cerebral venous sinus thrombosis
- Vasculitis
- RCVS

Neoplastic

- Primary or metastases
- Pituitary tumor/hemorrhage

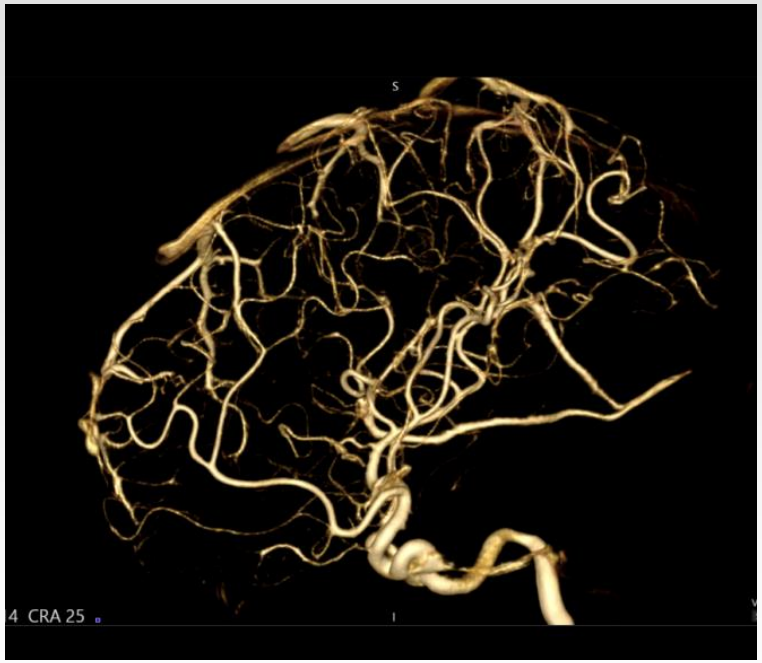
Infectious

- Meningoencephalitis
- Cerebritis/brain abscess

CSF/Pressure related

- Chiari malformation
- Increased hypertension

"Worst headache of life" – endovascular treatment for vascular diseases



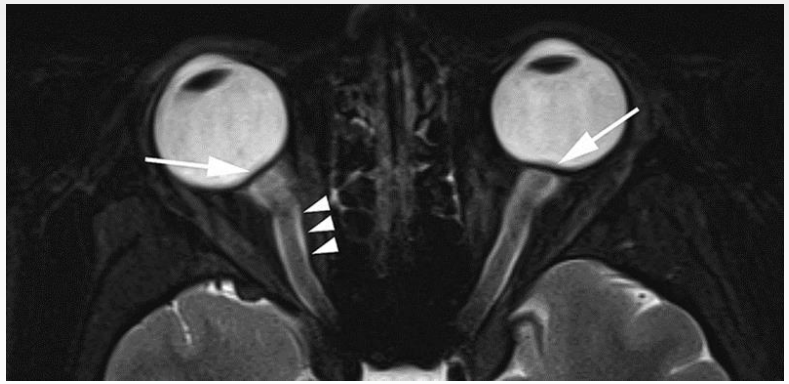
Most headaches with non-traumatic subarachnoid hemorrhage requires further endovascular workup

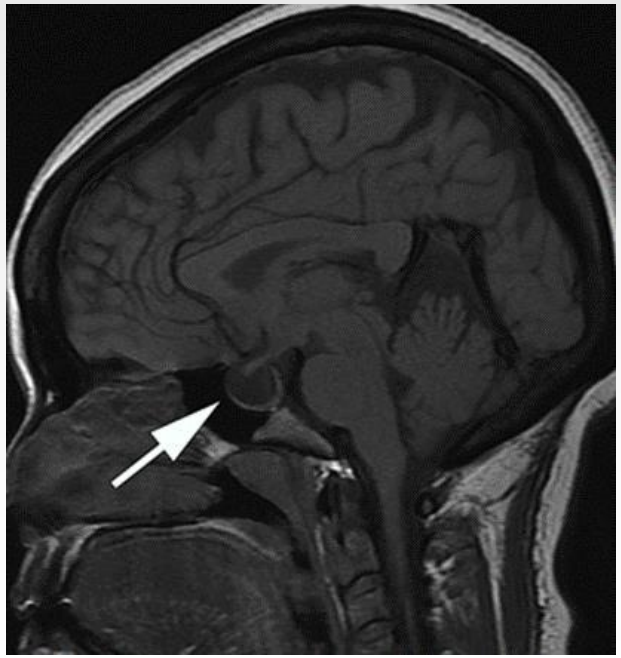
Novel endovascular treatment for pressure-related headaches

“Idiopathic intracranial hypertension” (*formerly pseudotumor cerebri) –*

another headache disease Neurosurgeons are familiar with…

- Daily headaches
- Increased intracranial pressure without mass lesion
- common in females and elevated BMI

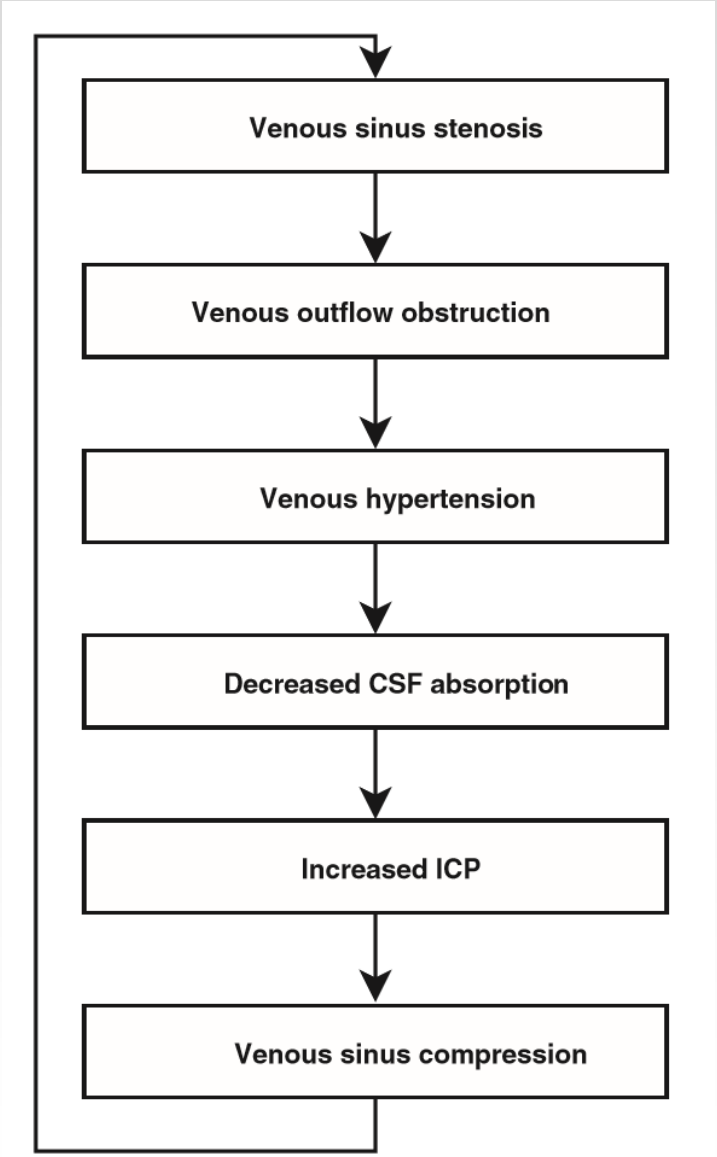




Increased Intracranial Hypertension (IIH)

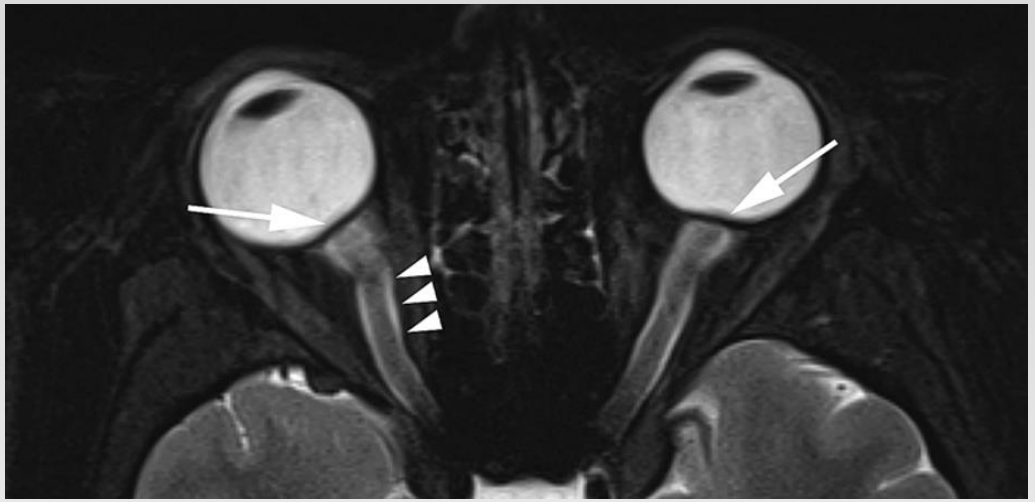
- Originally proposed by Walter Dandy, a neurosurgeon, in 1937
- High intracranial pressure without obvious structural cause, leading to:
  - Headache
  - Visual disturbance
  - Pulsatile tinnitus
- Cause unclear – venous outflow obstruction?
- Incidence: 1/100,000
- 20x incidence in female, 20-44 years, BMI > 20% over ideal body weight
- Risk of permanent vision loss

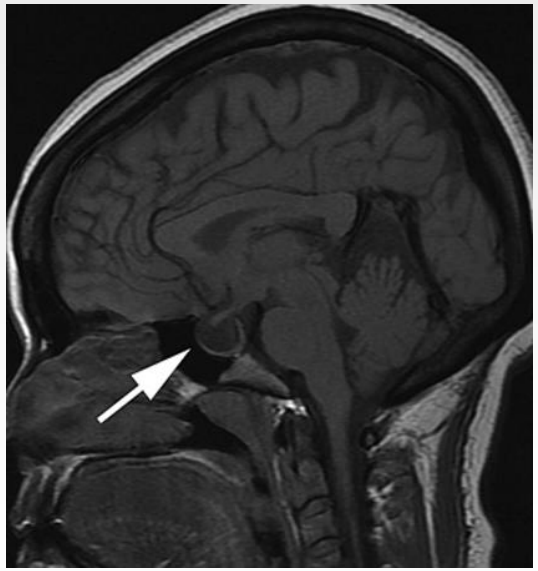
Proposed IIH Pathophysiology

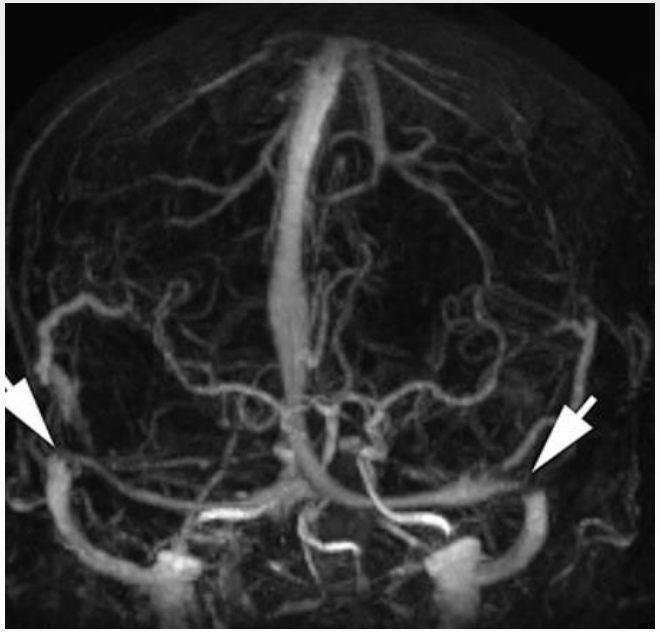


Biousse et al. 2012 JNNP

- Ophthalmology/Neuro-ophthalmology Assessment
  - Papilledema
  - Visual fields/perimetry
  - Retinal optical coherence tomography (OCT)
- MRI/MRV
  - Optic disc swelling, flattened globes, optic nerve kinking and expansion
  - Empty sella
  - Bilateral TS/SS stenosis
- Lumbar puncture - opening pressure
  - Typically > 25 cmH2O
  - Occasionally requiring fluoroscopy due to large body habitus







IIH Management

- Serial ophthalmology/neuroophthalmology assessments
- Weight loss
- Carbonic anhydrase inhibitor: Acetazolomide/Diamox
- LP – can be therapeutic
- Referral for possible surgical management
  - Failure of medical treatment
  - Refractory headaches with persistent elevated ICP
  - Fulminant cases

- Surgical options:
  - Optic nerve sheath fenestration
  - CSF diversion
    - Ventriculoperitoneal shunt
    - Lumboperitoneal shunt
  - TS/SS stenting

Stenting in Increased Intracranial Hypertension (IIH)

ORIGINAL RESEARCH

Venous sinus stenting for idiopathic intracranial hypertension: a systematic review and meta-analysis

Patrick Nicholson,[1] Waleed Brinjikji,[1] Ivan Radovanovic,[2,3] Christopher Alan Hilditch,[1] Anderson Chun On Tsang,[1] Timo Krings,[1] Vitor Mendes Pereira,[1,2] Stéphanie Lenck[1,4]

Nicholson P, *et al*. *J NeuroInterv Surg* 2018;**0**:1–7. doi:10.1136/neurintsurg-2018-014172

Target population: PTC patients refractory to medical therapy

Treatment: Venous sinus stenting

Meta-analysis: IIH and venous sinus stenting

- Recurrence of symptoms: 9.8%
- Repeat endovascular procedure: 9%
- Subsequent CSF diversion procedure: 3%
- Complications: 1.9%
  - SDH/SAH: 4 patients
  - Retroperitoneal hematoma requiring transfusion: 2 patients
  - Femoral pseudoaneurysm: 2 patients
- Mortality: 0%

Table 2 Outcome data

Author	Presenting symptoms			Improvement in symptoms post-stent			Major complication	Need of second procedure	Subsequent endovascular	Subsequent CSF diversion	Mean CSF pressure post-tenting (min–max)
	HA	PA	PT	HA	PA	PT					
Higgins *et al*[13] 2003	12	8	NR	7	5	NR	0	2	2	0	NR
Donnet *et al*[12] 2008	10	10	5	8	10	5	0	1	1	0	14 (9–19)
Bussière *et al*[11] 2010	10	10	3	10	10	NR	0	0	0	0	NR
Ahmed *et al*[8] 2011	43	45	17	35	45	17	2 (SDH)	6	6	0	22 (12–39)*
Albuquerque *et al*[14] 2011	15	NR	NR	12	NR	NR	0	0	0	0	NR
Fields *et al*[16] 2013	15	15	14	10	15	11	0	1	0	1	NR
Ducruet *et al*[15] 2014	30	30	NR	19	30	NR	0	5	0	5	NR
Goodwin *et al*[21] 2014	15	13	13	12	13	13	0	3	0	3	NR
Teleb *et al*[22] 2015	18	18	5	10	18	4	0	6	6	0	NR
Liu *et al*[23]* 2016	10	7	5	9	7	NR	0	2	2	0	NR
Boddu *et al*[10] PLOS 2016	29	13	29	NR	NR	28	0	2	0	0	NR
Kumpe *et al*[17 18] 2012 –2016	31	37	NR	23	33	NR	2 (SDH, SAH)	8	8	0	NR
Aguillar-Pérez *et al*[24] 2017	37	50	9	31	42	9	0	8	8	0	NR
Satti *et al*[25] 2017	43	22	NR	27	13	NR	0	2	2	0	NR
Shazly *et al*[26] 2017	NR	6	NR	NR	6	NR	0	0	0	0	NR
Silva *et al*[27] 2017	6	6	NR	6	5	NR	0	0	0	0	26 (23–27)
Smith *et al*[28] 2017	17	11	8	15	9	3	0	2	2	0	22 (12–34)†
Lenck *et al*[19] 2017	20	21	14	19	21	14	0	0	0	0	NR
Asif *et al*[9] 2017	41	30	21	26	24	12	0	3	3	0	NR
El Mekabaty *et al*[29] 2017	31	31	19	23	30	18	0	8	1	7	NR
Totals	433	383	162	302	336	134	4	59	41	16	21

Meta-analysis: IIH and venous sinus stenting

- 20 articles (retrospective and prospective series)
- 18 different centers
- N=474
- Age 35 (mean)
- 88% female
- BMI 35 (mean, range 15-73)
- F/u duration 18 months (median)

Table 1 Patient characteristics

Author	Number of patients/female	Mean age (min –max)	Mean BMI (min–max)	Mean CSF opening pressure (min–max)	Stenting as first procedure	Mean gradient (min–max)	FU months	Risk of study bias (as measured by modified Newcastle–Ottawa Scale)
Higgins *et al*[13] 2003	12/12	33 (19–52)	37 (29–45)	34 (25–46)	7	19 (8–37)	14 (2–26)	Moderate
Donnet *et al*[12] 2008	10/8	42 (28–60)	27 (22–37)	40 (29–59)	10	19 (12–34)	17 (6–36)	Moderate
Bussière *et al*[11], 2010	10/10	34 (16–65)	36 (27–48)	NR	10	28 (11–50)	20 (4–60)	Moderate
Ahmed *et al*[8] 2011	52/47	34 (10–64)	NR	32 (25–73)	43	19 (4–41)	24 (2–108)	Moderate
Albuquerque *et al*[14] 2011	15/12	31 (12–51)	NR	NR	NR	NR	20 (2–40)	Moderate
Fields *et al*[16] 2013	15/15	34 (20–56)	39 (30–73)	NR	9	24 (13–40)	14 (1–49)	High
Ducruet *et al*[15] 2014	30/25	33 (14–52)	NR	NR	NR	21 (10–56)	23 (3–59)	Moderate
Goodwin *et al*[21] 2014	18/17	40 (21–56)	33 (25–51)	37 (25–55)	18	15 (0–42)	9 (0–23)	High
Teleb *et al*[22] 2015	18/15	30 (15–59)	36 (23–59)	NR	13	14 (1–40)	25 (1–44)	Moderate
Liu *et al*[23] 2016	10/9	34 (17–59)	42 (25–56)	43 (27–55)	6	30 (14–52)	24 (16–32)	Moderate
Bodduet *al*[10] 2016	29/28	30 (16–59)	37 (19–52)	NR	29	17 (9–37)	26 (3–44)	Moderate
Kumpe *et al*[17 18] 2012 –2016	39/28	36 (16–62)	34 (NR)	40 (NR)	8	23 (10–43)	27 (NR)	Moderate
Aguillar-Pérez *et al*[24] 2017	51/41	40 (5–66)	31(15-47)	36 (19–60)	47	17 (1–39)	49 (NR)	Moderate
Satti *et al*[25] 2017	43/39	35 (21–54)	35 (21–56)	36 (14–56)	35	17 (7–46)	14 (1–63)	Moderate
Shazly *et al*[26] 2017	6/6	32 (18–47)	39 (33–43)	40 (NR)	6	29 (NR)	6 (6–6)	Moderate
Silva *et al*[27] 2017	6/5	40 (22–53)	NR	40 (17–48)	6	12 (9–17)	11 (7–16)	Moderate
Smith *et al*[28] 2017	17/15	30	35 (25–46)	38 (26–55)	17	23 (13–41)	18 (3–36)	Low
Lenck *et al*[19] 2017	21/19	33 (NR)	29 (NR)	33 (NR)	21	14 (NR)	14 (NR)	Low
Asif *et al*[9] 2017	41/39	36 (19–55)	NR	NR	26	28 (NR)	3 (3–4)	Moderate
El Mekabaty *et al*[29] 2017	31/29	34 (18–67)	39 (NR)	NR	31	20 (NR)	NR	High
Totals	474/419	35	35.27	37	342	21	19	

Meta-analysis: IIH and venous sinus stenting

- Venous sinus stent as primary treatment: 78%
- CSF opening pressure: 37 cmH2O range 14-73)
- Pressure gradient: 21 mmHg

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Silva *et al*[27] 2017	6/5	40 (22–53)	NR	40 (17–48)	6	12 (9–17)	11 (7–16)	Moderate
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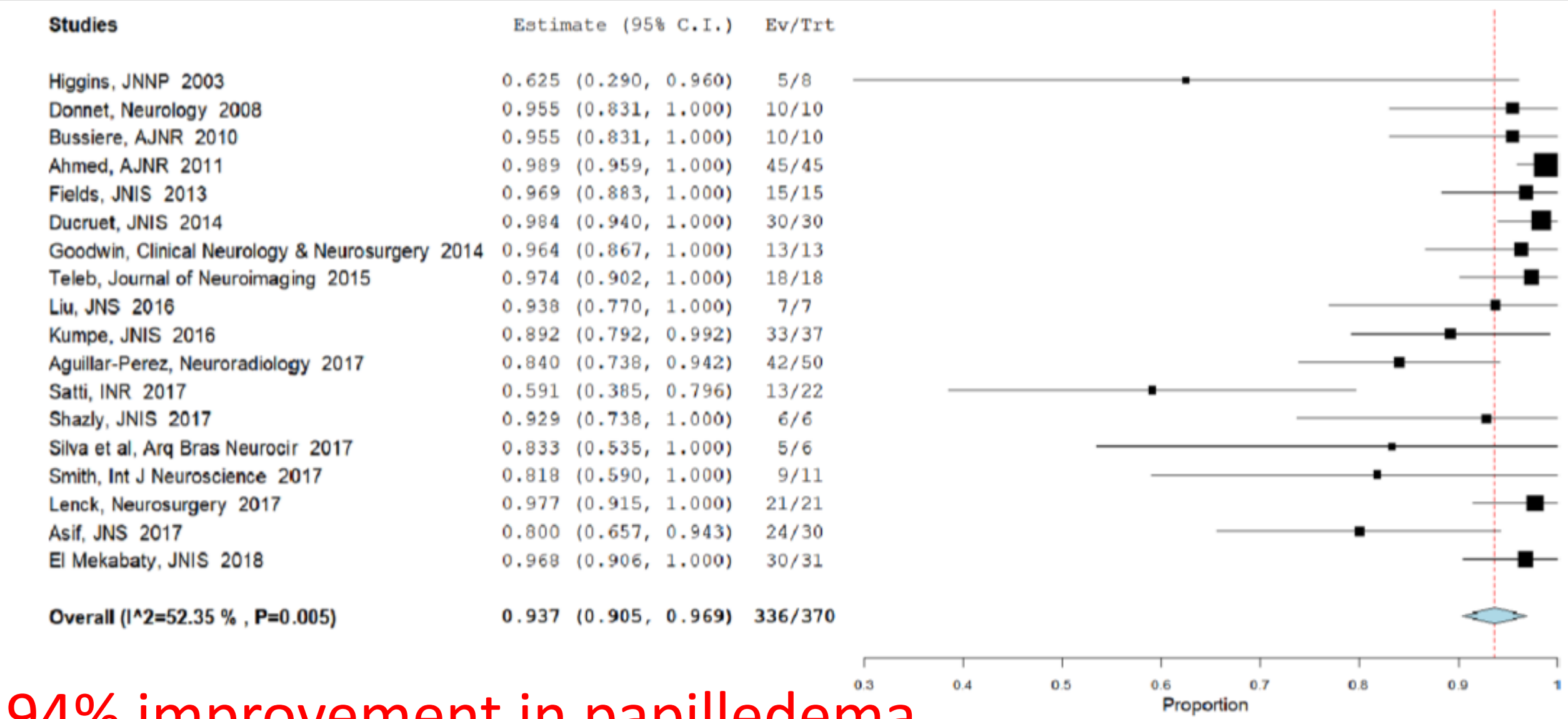
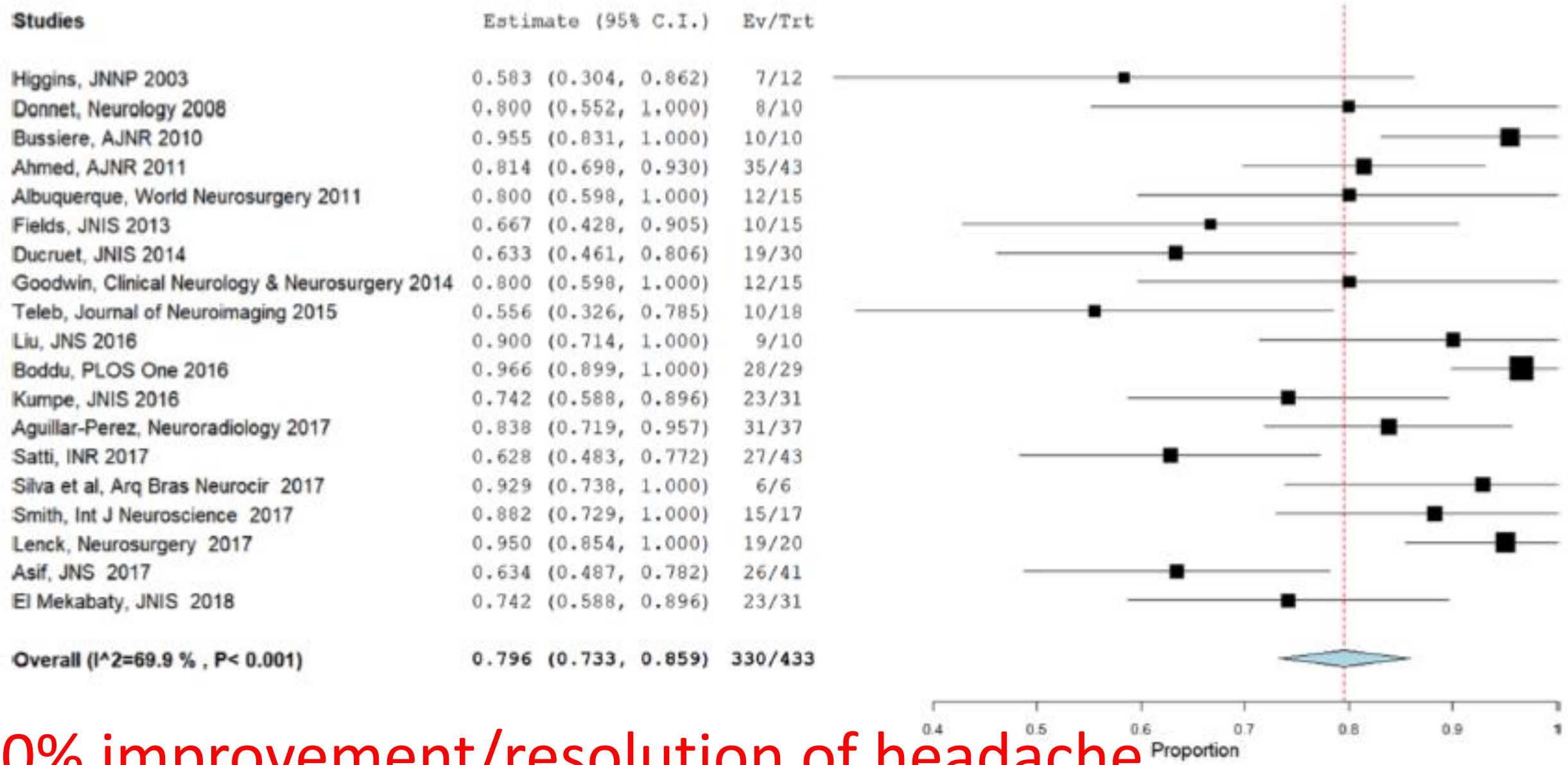


94% improvement in papilledema

Figure 1 Forest plot – papilledema outcomes.



80% improvement/resolution of headache

Figure 2 Forest plot – headache outcomes.

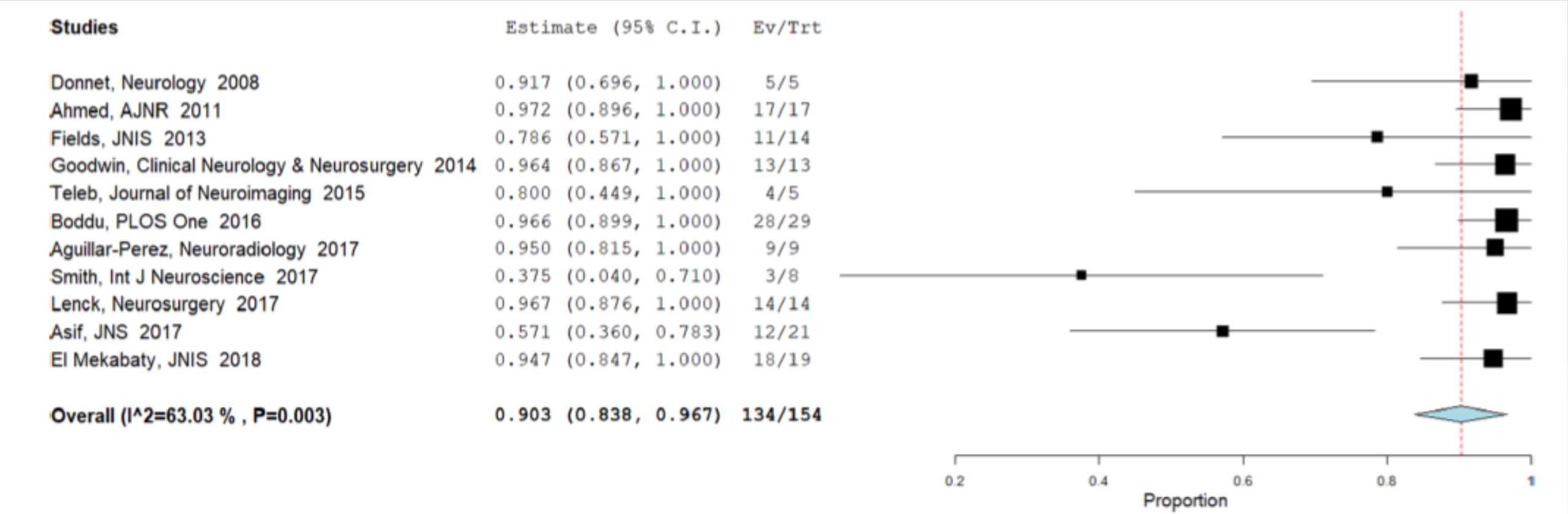


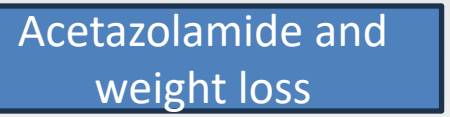
Figure 3 Forest plot – pulsatile tinnitus outcomes.

90% resolution of pulsatile tinnitus

Management of IIH

Work up:
MRI of the brain
Ophthalmology evaluation
Lumbar puncture for OP

First line therapy



Refractory

Vascular complications – ocular motility disorder, pupillary dysfunction

High rate of revision surgery
Shunt infection, subdural hematoma, CSF leak

Increasing awareness IIH as a vascular (venous) problem…

- Hypothesis: increased pressure result from venous outflow blockage
- Venous sinus stenting improves pressure?

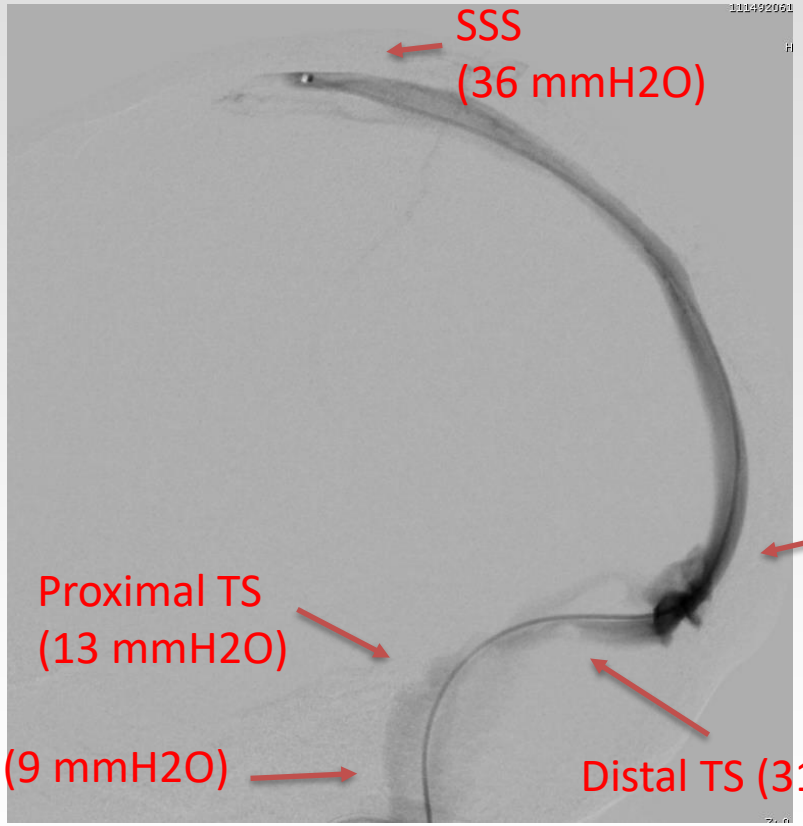
In refractory IIH patients with non-invasive imaging with venous stenosis

- Diagnostic cerebral venogram under moderate conscious sedation
- Measure gradient across the site of outflow obstruction (usually 8 or higher)

Case Example

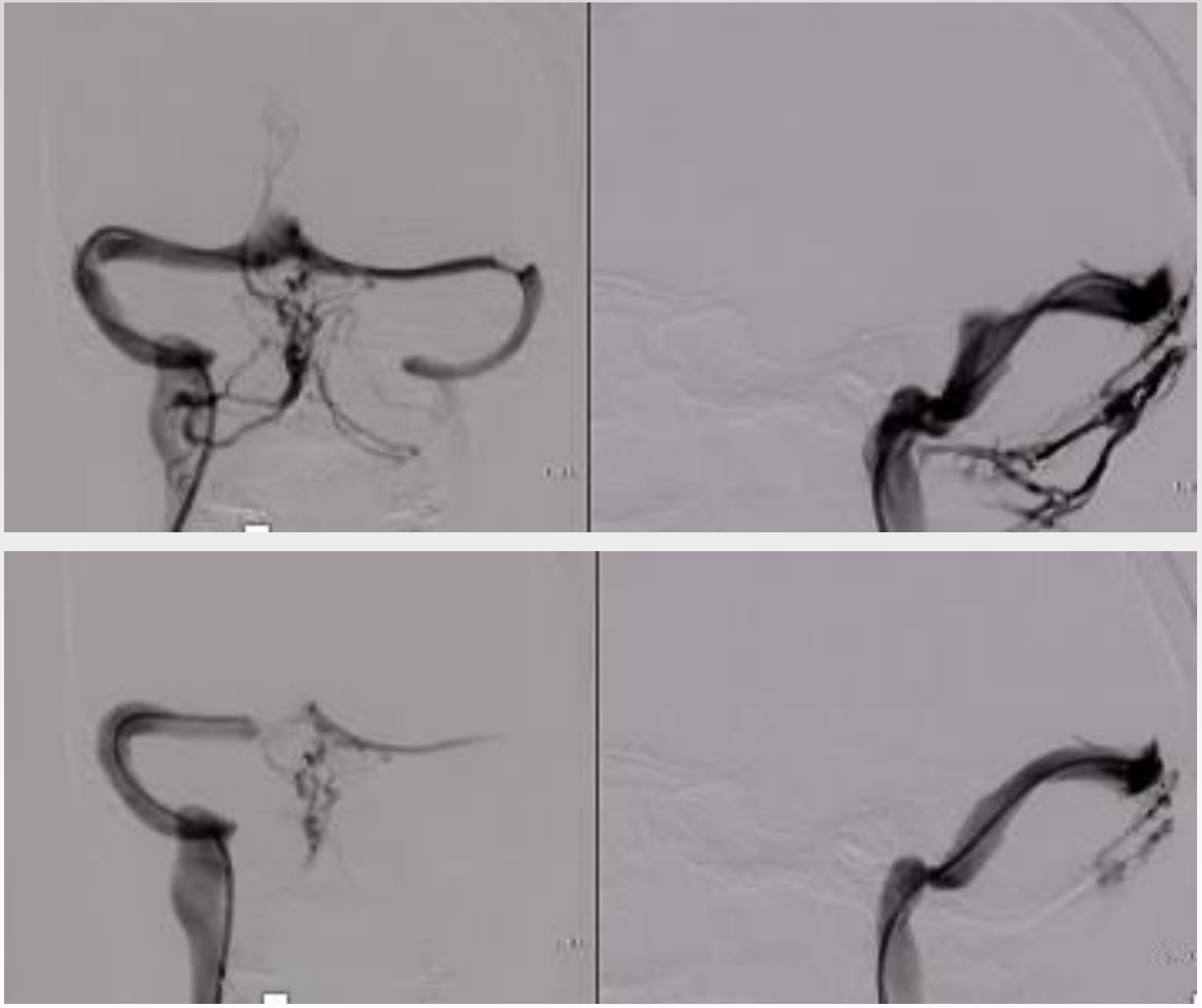
- A woman in her 20s presented with daily headaches, pulsatile tinnitus and blurry vision.
  - Lumbar puncture opening pressure was 41.
  - Ophthalmology evaluation confirmed papilledema.
- MRI/MRV work up with concern for transverse sinus stenosis.
- Started on acetazolamide but could not tolerate due to side effects
- Patient underwent diagnostic cerebral angiogram (moderate conscious sedation) for further workup

Pressure manometer reading confirmed pressure gradient



Location	LEFT Pressure (mmH2O)	RIGHT Pressure (mmH2O)
Superior sagittal sinus	36	
Torcula	33	
Distal transverse sinus	**31**	**30**
Proximal transverse sinus	**13**	**9**
Sigmoid sinus	15	9
Jugular bulb	14	7

- Patient was started on dual antiplatelet therapy (DAPT) and returned 1 week later for transverse sinus stenting under moderate conscious sedation



Post stenting

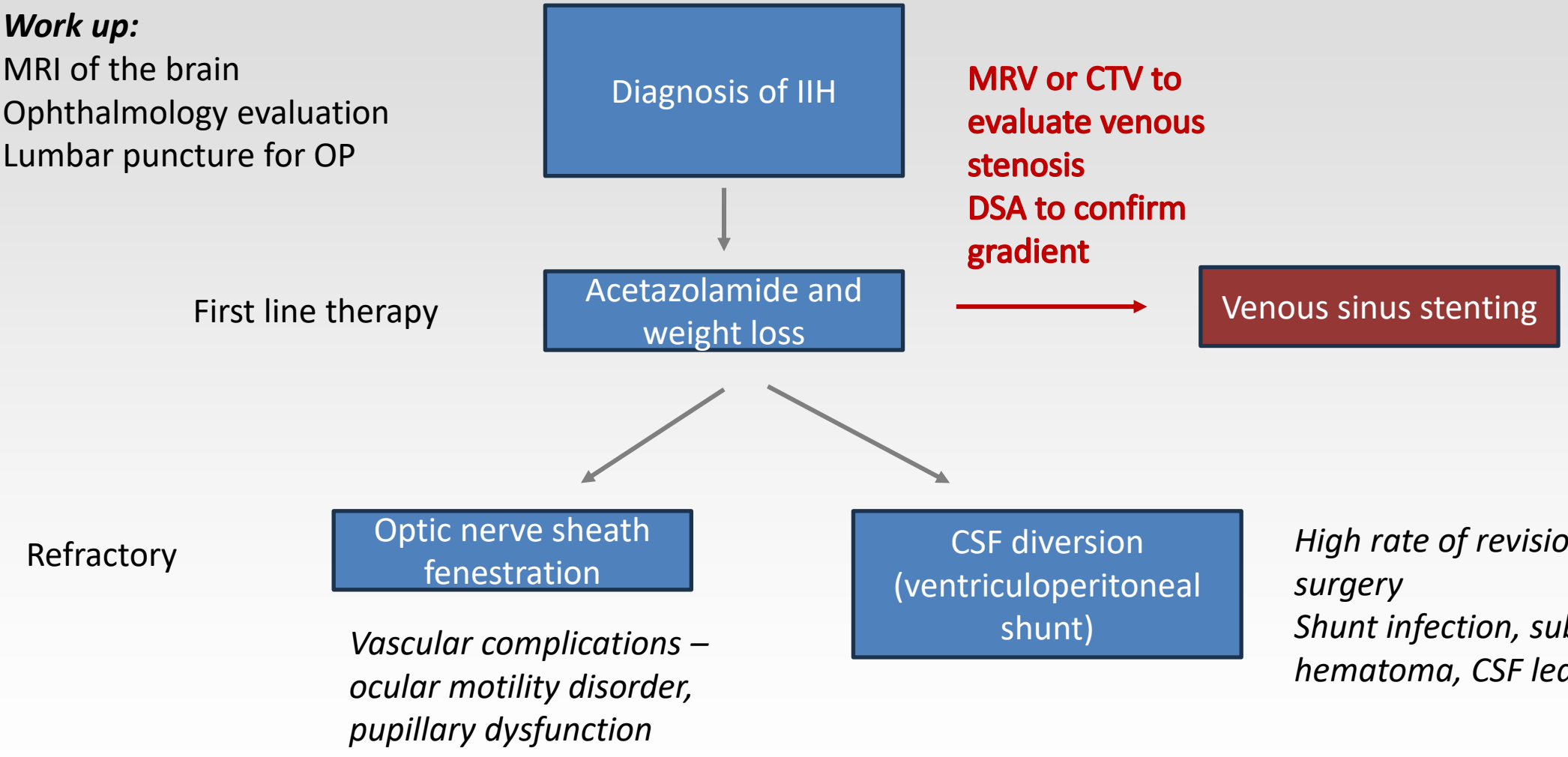
Patient had improvement of headaches at follow up visit.

Is venous sinus stenting safe or durable?

- Recurrence of symptoms: 9.8% (still relatively new)
- Subsequent CSF diversion procedure: 3%
- Complications: 1.9%
  - SDH/SAH: 4 patients
  - Retroperitoneal hematoma requiring transfusion: 2 pts
  - Femoral pseudoaneurysm: 2 pts
  - Mortality 0%
  - Delayed complications? Optic disc atrophy and stent thrombosis

Updated Management of IIH

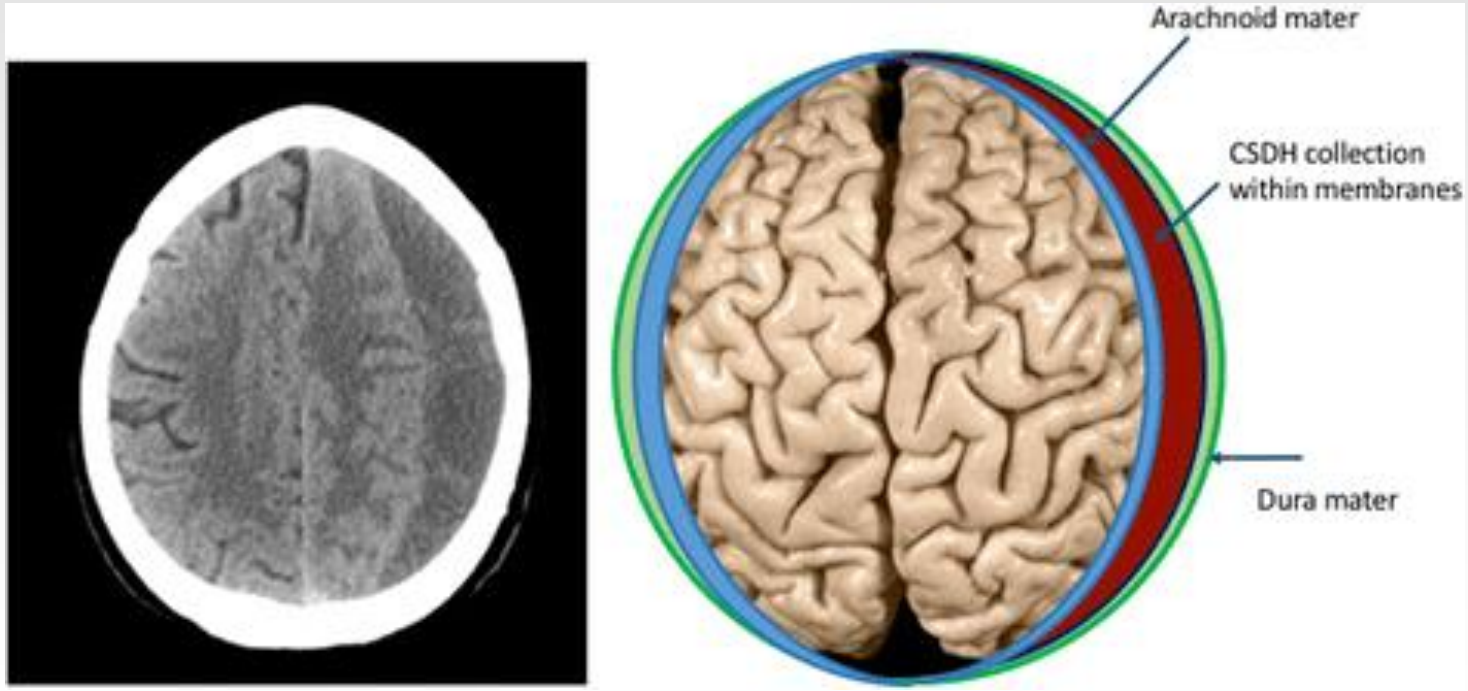
Work up:
MRI of the brain
Ophthalmology evaluation
Lumbar puncture for OP



Another new frontier in endovascular management of headaches for an old neurosurgical problem…

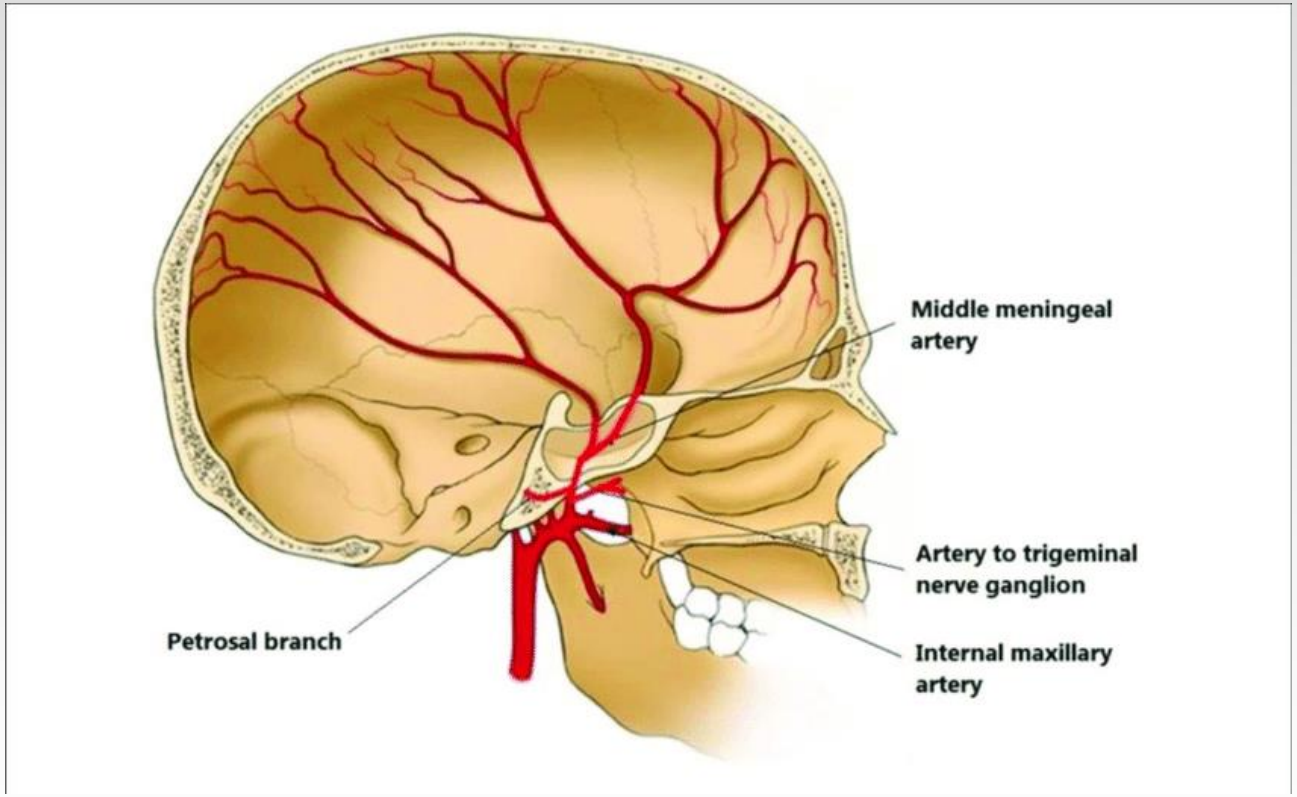
Chronic subdural hematomas

- More prevalent in increasing aging population, increased anticoagulation/antiplatelet use



Middle meningeal artery (MMA) embolization

- Inflammatory response of dural layer (neovascularization and granulation)
- Embolization stops rebleeding and inflammation cascade

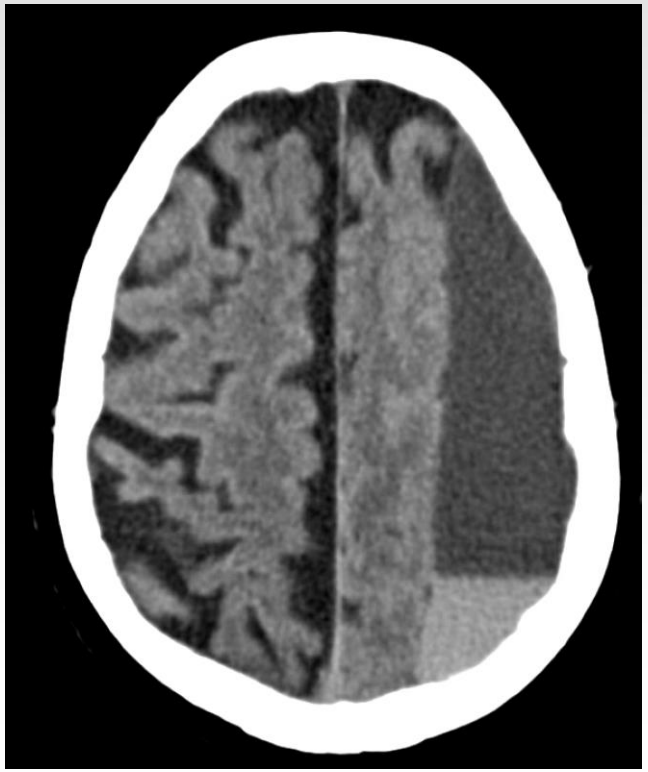


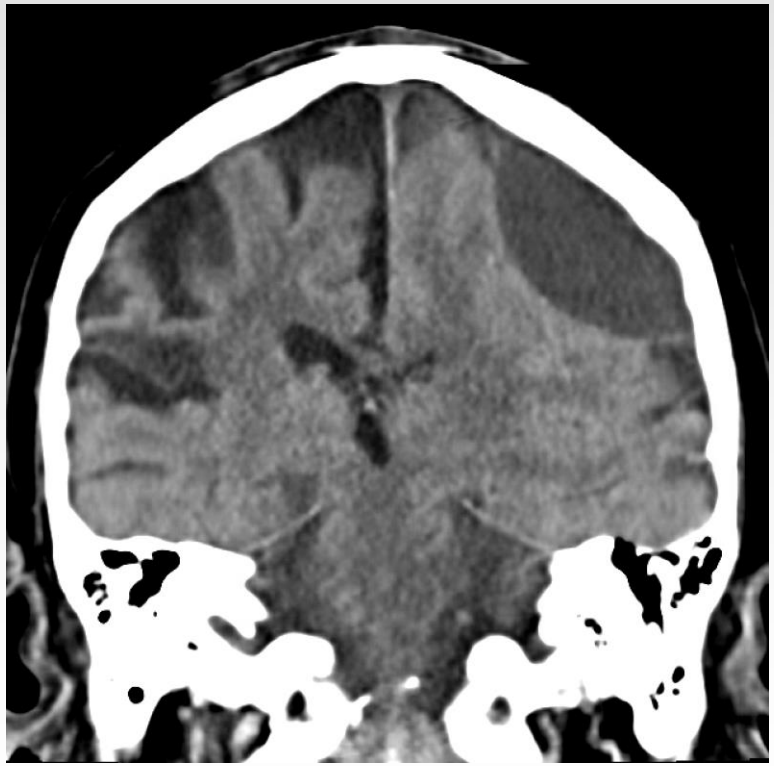
Why MMA embolization may be more suitable for some patients than surgery?

- Under conscious sedation (avoid GA in high-risk medical patients)
- No need to stop antiplatelet/anticoagulant
- Potentially restart antiplatelet/anticoagulant earlier
- Lower risk of bleeding/infection
- Older patients who cannot tolerate surgery

Case Example

- 84 year old man with afib on Eliquis presented after a fall 2 weeks ago. Reported increasing headaches



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Aneurysm E
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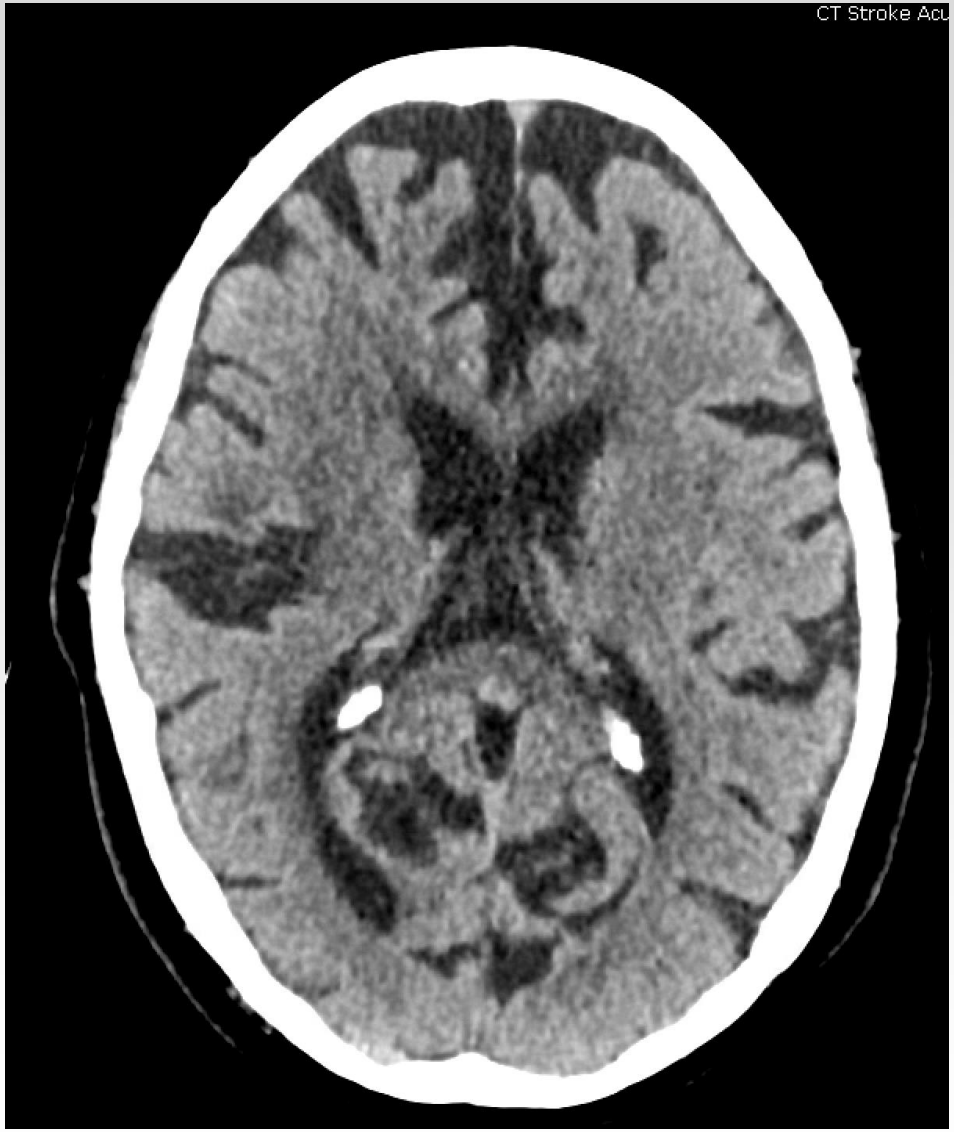
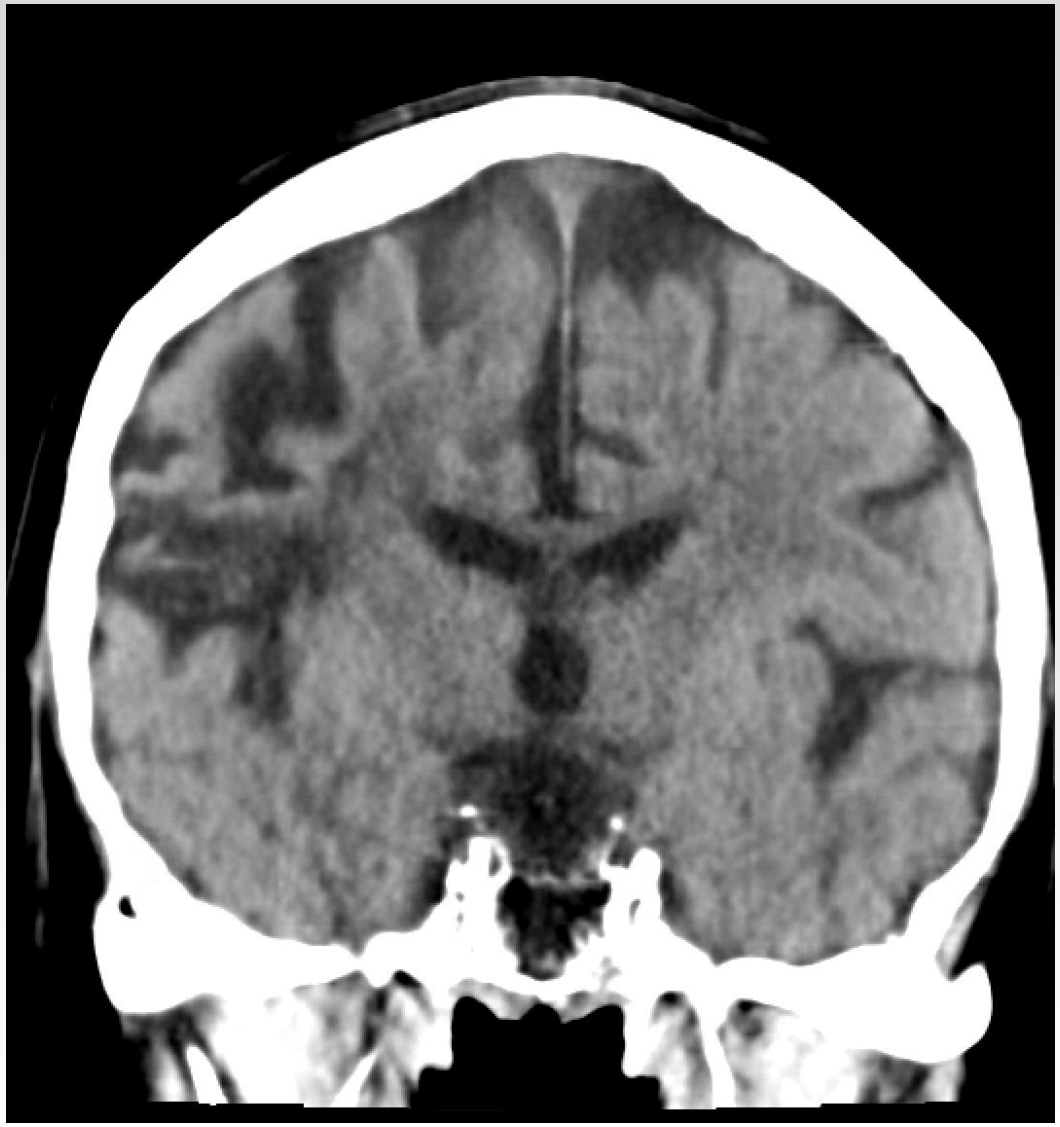




- 3 month follow up with resolution of headaches

EMBOLISE trial : hallmark trial

EMBOLISE: Embolization of the MMA with Onyx™ Liquid Embolic System in the Treatment of Subacute and Chronic Subdural Hematoma

RESULTS: In participants with symptomatic subacute or chronic subdural hematoma (SDH), the addition of middle meningeal artery (MMA) embolization with Onyx™ resulted in nearly a 3-fold reduction in hematoma recurrence/progression requiring re-operation compared to surgery alone.

PURPOSE: To assess both the safety and effectiveness of utilizing the Onyx™ Liquid Embolic System (LES) for embolization of the MMA in the treatment of symptomatic subacute or chronic SDH as an adjunct to conventional treatment.

TRIAL DESIGN: A multicenter, prospective, randomized, interventional controlled, open-label, adaptive trial (n=400).

	Onyx Embo +Surgery (Treatment) N=197	Surgery Only (Control) N=203	Relative Risk (95%CI)	P value
Primary Endpoint				
SDH recurrence/progression requiring surgical drainage through 90 days (ITT population)	4.1 % (1.8%, 7.8%)	11.3% (7.3%, 16.5%)	0.36 (0.11, 0.80)	0.0081
Secondary Endpoints				
Incidence of deterioration in neurologic function	11.9% (21/177) (7.5%, 17.6%)	9.8% (18/184) (5.9%, 15.0%)	2.08% (-4.76%, 8.92%)	0.0022

Key Takeaways: The use of MMA embolization is a promising additional approach to the surgical management of subacute or chronic SDH.

International Stroke Conference

Presented by: Jason Michael, Michael Davies, U-Buff International Stroke Conference 2024

#ISC24

Endovascular therapy for migraine headache

The next frontier

Infusion of lidocaine into the MMA to treat migraine

- Considering that the ‘vasocentric’ theories of migraine have focused on the MMA and dural pain receptors, the concept of a direct infusion of lidocaine into the MMA is certainly attractive

- Infusion of lidocaine in MMA achieves a substantially higher local concentration of lidocaine directly at the proposed site of primary pathology, potentially achieving better effectiveness while avoiding the potential systemic toxicity

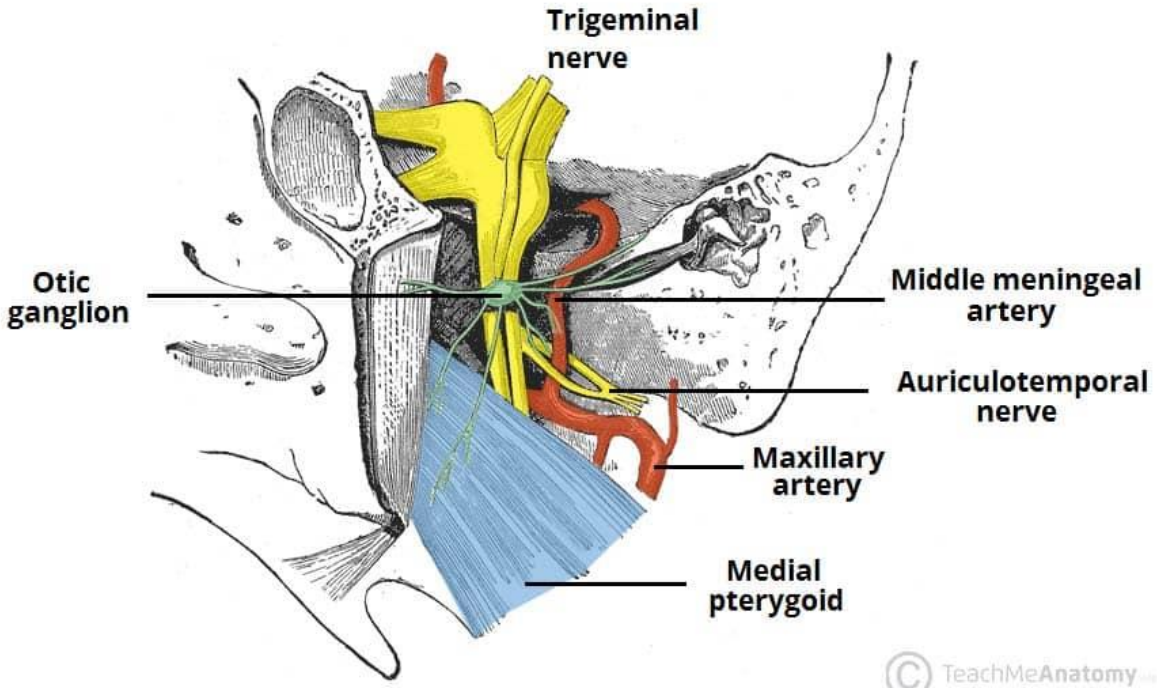
J Neuroimaging. 2018 Jan;28(1):79-85. doi: 10.1111/jon.12476. Epub 2017 Oct 6.

Intra-arterial Modulation of the Trigeminal Nerve Ganglion in Patients with Refractory Trigeminal Neuralgia

Adnan I Qureshi [1 2], Muhammad A Saleem [1 2], Vikram Jadhav [1], Shawn S Wallery [2], Faisal Raja [2]

Affiliations + expand

PMID: 28984397 DOI: 10.1111/jon.12476



J Vasc Interv Neurol. 2014 Dec;7(5):69-72.

Effect of intra-arterial injection of lidocaine and methyl-prednisolone into middle meningeal artery on intractable headaches

Adnan I Qureshi [1], Mushtaq H Qureshi [1], Asif A Khan [1], M Fareed K Suri [1]

Affiliations + expand

PMID: 25566345 PMCID: PMC4280869

J Neuroimaging. 2021 Nov;31(6):1126-1134. doi: 10.1111/jon.12918. Epub 2021 Aug 13.

Intra-arterial injection of lidocaine into middle meningeal artery to treat intractable headaches and severe migraine

Adnan I Qureshi [1 2], Kimberley Pfeiffer [1], Sehar Babar [3], Wei Huang [1 2], Iryna Lobanova [1 2], Muhammad F Ishfaq [1], Brandi R French [1], Farhan Siddiq [4], Camilo R Gomez [1]

Affiliations + expand

PMID: 34388298 DOI: 10.1111/jon.12918

Refractory migraine: a cerebrovascular disease?

David Fiorella [1,2], Adam S Arthur [3,4], Hsiangkuo Yuan,[5] Pervinder Bhogal [6], Nitin Goyal,[3] Nicolas K Khattar [7], Felipe C Albuquerque [8], Ashutosh P Jadhav [9], Joshua S Catapano [10], Stephen Silberstein[5]

Intra-arterial lidocaine therapy via the middle meningeal artery for migraine headache: Theory, current practice and future directions

Marco Mancuso-Marcello[1], Adnan I. Qureshi[2], Christos Nikola[3], Irina Stoian[3], YiFan Jia[4], Danial Saeed[3] and Pervinder Bhogal[1]

Disease Background

- ‘Trigeminovascular hypothesis’ is the leading underlying pathophysiologic mechanism of migraines
  - Complex interplay between the central nervous system, trigeminal nerve, along with dural and pial arteries
- Patient cohort
  - Who have failed an extensive regimen of anti-migraine and analgesic medications with or without procedural (botox) interventions for debilitating migraines

Innervation of dura

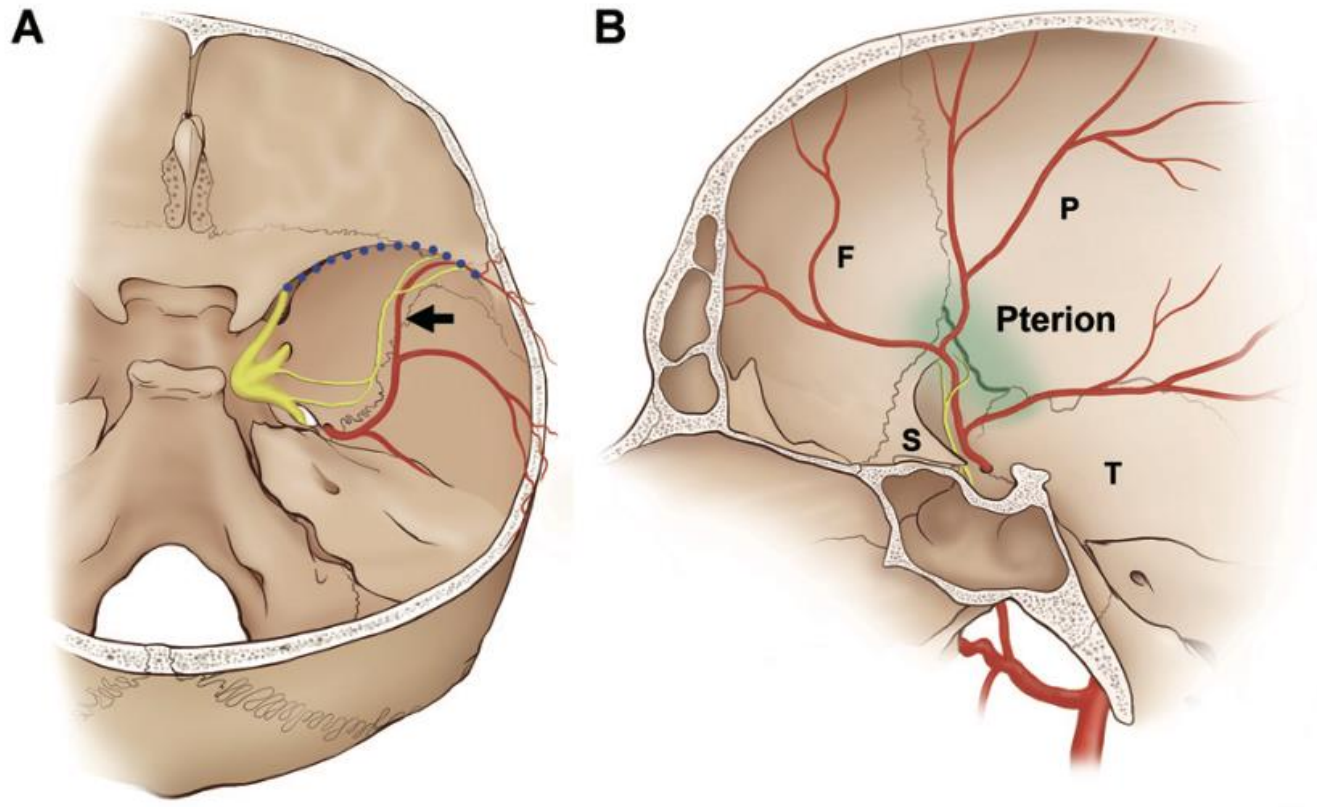


FIGURE 6 | Schematics of the dominant distribution of the NS. In approximately 80% of cases, the NS terminated at the intersection of the frontal branches of the MMA (black arrow) and the sphenoparietal sinus (blood dotted line). **(A)** Posterior view of the middle cranial fossa. **(B)** Medial view of the middle cranial fossa. The interface with the frontal branches of the MMA and the sphenoparietal sinus coincides with the pterion (green line), which is the region where the frontal (F), parietal (P), sphenoid (S) and squamous parts of the temporal bones (T) join together.

IA lidocaine injection into MMA to treat migraine : Case series

JOURNAL OF NEUROIMAGING
THE OFFICIAL JOURNAL OF THE AMERICAN SOCIETY OF NEUROIMAGING

CLINICAL INVESTIGATIVE STUDY

Intra-arterial injection of lidocaine into middle meningeal artery to treat intractable headaches and severe migraine

Adnan I. Qureshi, Kimberley Pfeiffer, Sehar Babar, Wei Huang, Iryna Lobanova, Muhammad F. Ishfaq, Brandi R. French, Farhan Siddiq, Camilo R. Gomez

First published: 13 August 2021 | https://doi.org/10.1111/jon.12918 | Citations: 1

Interventional Neuroradiology

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Intra-arterial lidocaine therapy via the middle meningeal artery for migraine headache: Theory, current practice and future directions

Marco Mancuso-Marcello, Adnan I. Qureshi, [...], and Pervinder Bhogal +4 View all authors and affiliations

Chronic headaches and middle meningeal artery embolization

Joshua S Catapano, Katherine Karahalios, Visish M Srinivasan, Jacob F Baranos
Caleb Rutledge, Tyler S Cole , Andrew F Ducruet, Felipe C Albuquerque ,
Ashutosh P Jadhav

Results Of 76 patients undergoing MMA embolization for a cSDH during the study period, 56 (74%) had a discharge GCS score of 15. Of these 56 patients, 46 (82%) responded to a follow-up telephone call and were analyzed (mean [SD] age 68 [11] years; 36 [78%] men and 10 [22%] women). Nine (20%) reported chronic headaches before embolization. With a mean (SD) follow-up of 489 (173) days, eight of the nine patients reported improvement of chronic headaches, with seven having complete resolution. For these nine patients, the mean (SD) HIT-6 score was significantly higher before embolization than after embolization (64 [7.1] vs 40 [9.1], $p<0.001$).

Conclusion In patients with chronic headaches who underwent MMA embolization for a cSDH, the majority reported improvement of headaches after the procedure. Future prospective studies are warranted to assess the usefulness of MMA embolization to treat chronic headaches.

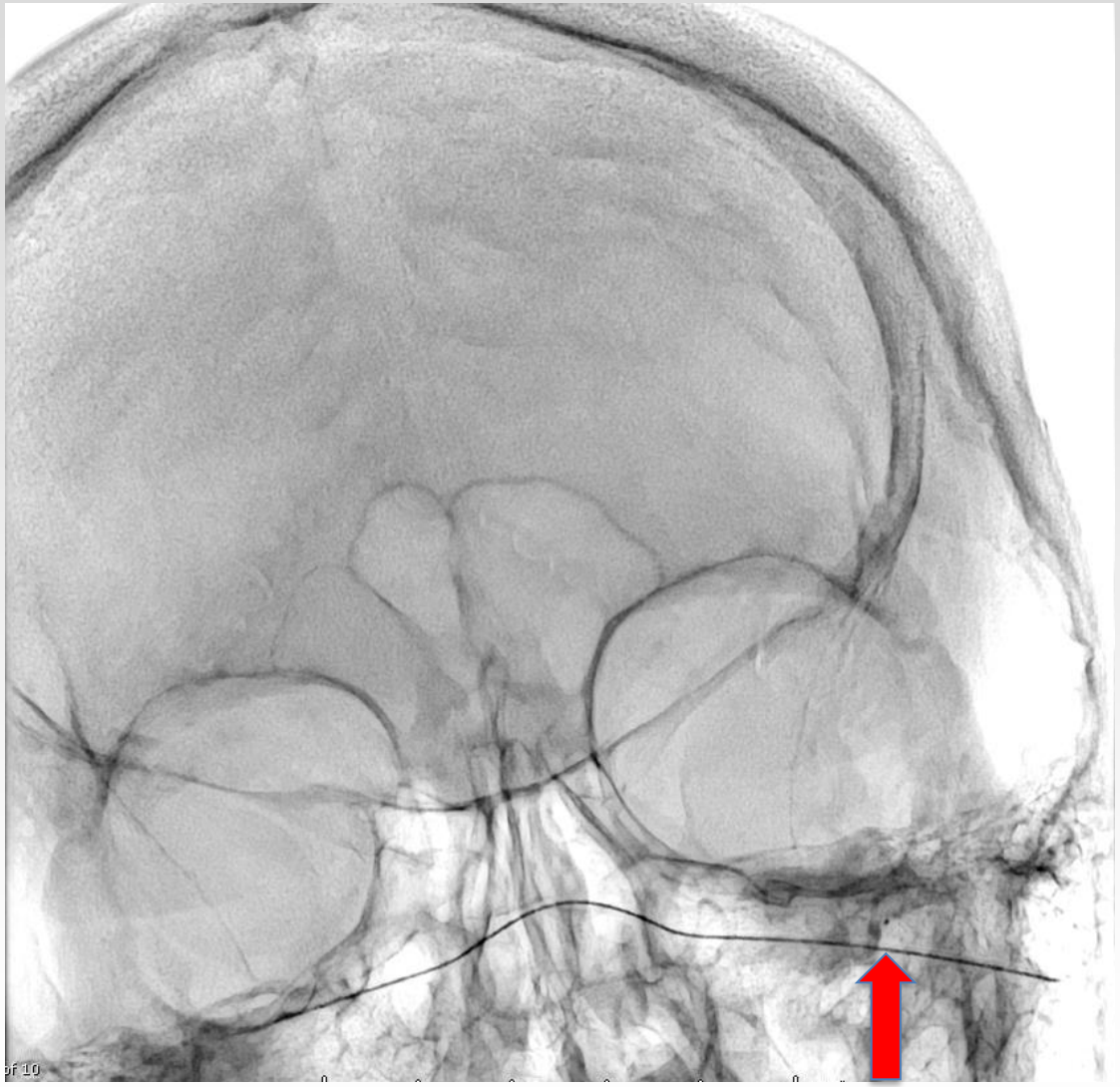
Case 1 – Intra-arterial Lidocaine

60yo female w/ history of chronic atypical headaches/migraines who presented for diagnostic cerebral angiogram and IA lidocaine to rule out RCVS and vasospasm.

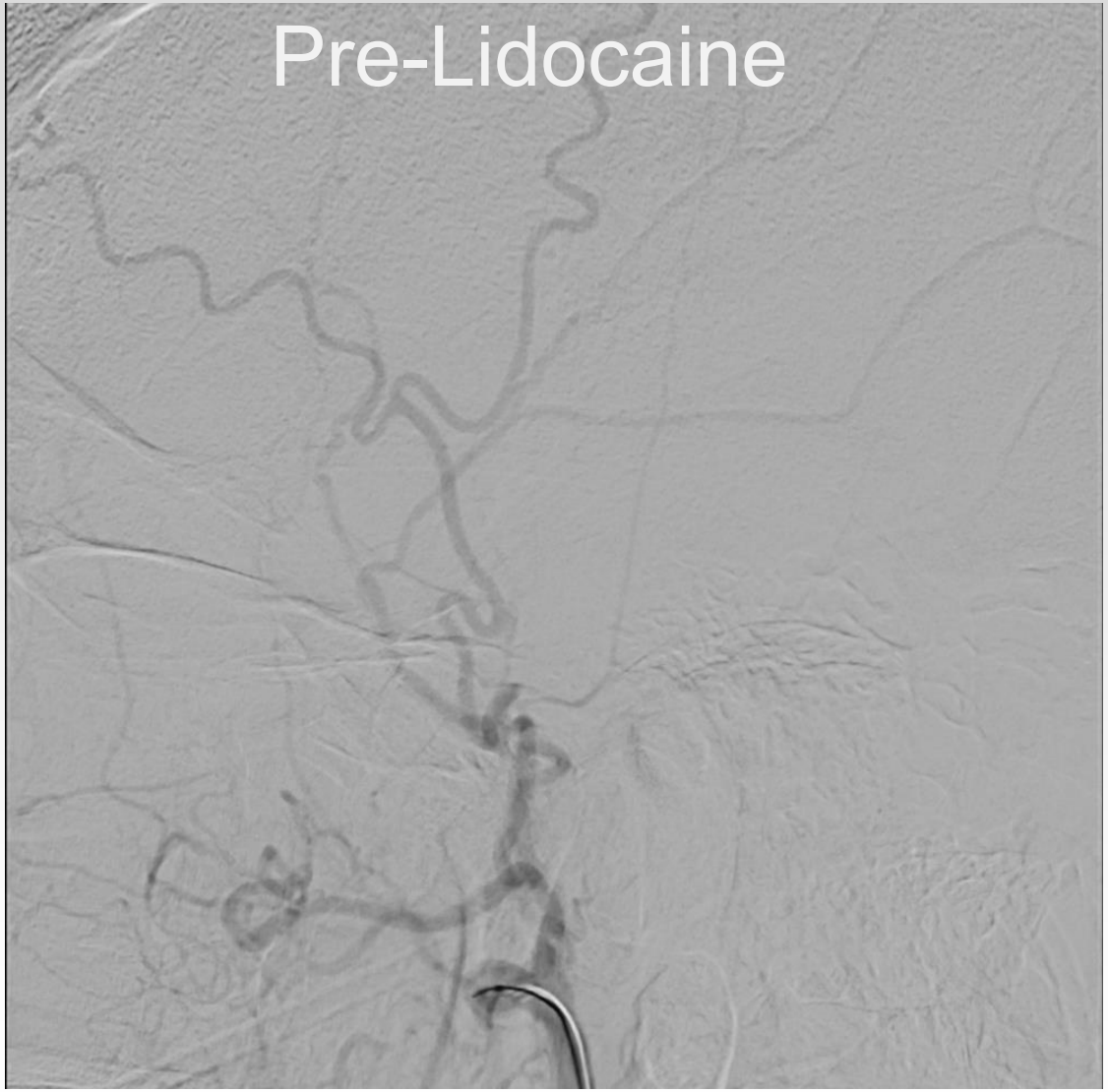
- Patient's headaches has been managed with neurology in which workup including LP revealed an opening pressure of 25. Patient was trialed on acetazolamide in which headaches have been refractory. Patient has been recently diagnosed with ADEM identified when pt presented to ED and found to have cerebral edema and workup was conducted.
- PMH: hypertension, hyperlipidemia, depression, glaucoma, chronic pain, uveitis
- Social History: Non-smoker. Denies EtOH use.
- Exam: Neurologically Intact.

- Given refractory headaches, patient recommended as candidate for chronic migraine study for neural stimulants. Patient recommended for DSA to rule out vasospasm and RCVS which is an exclusion criteria.

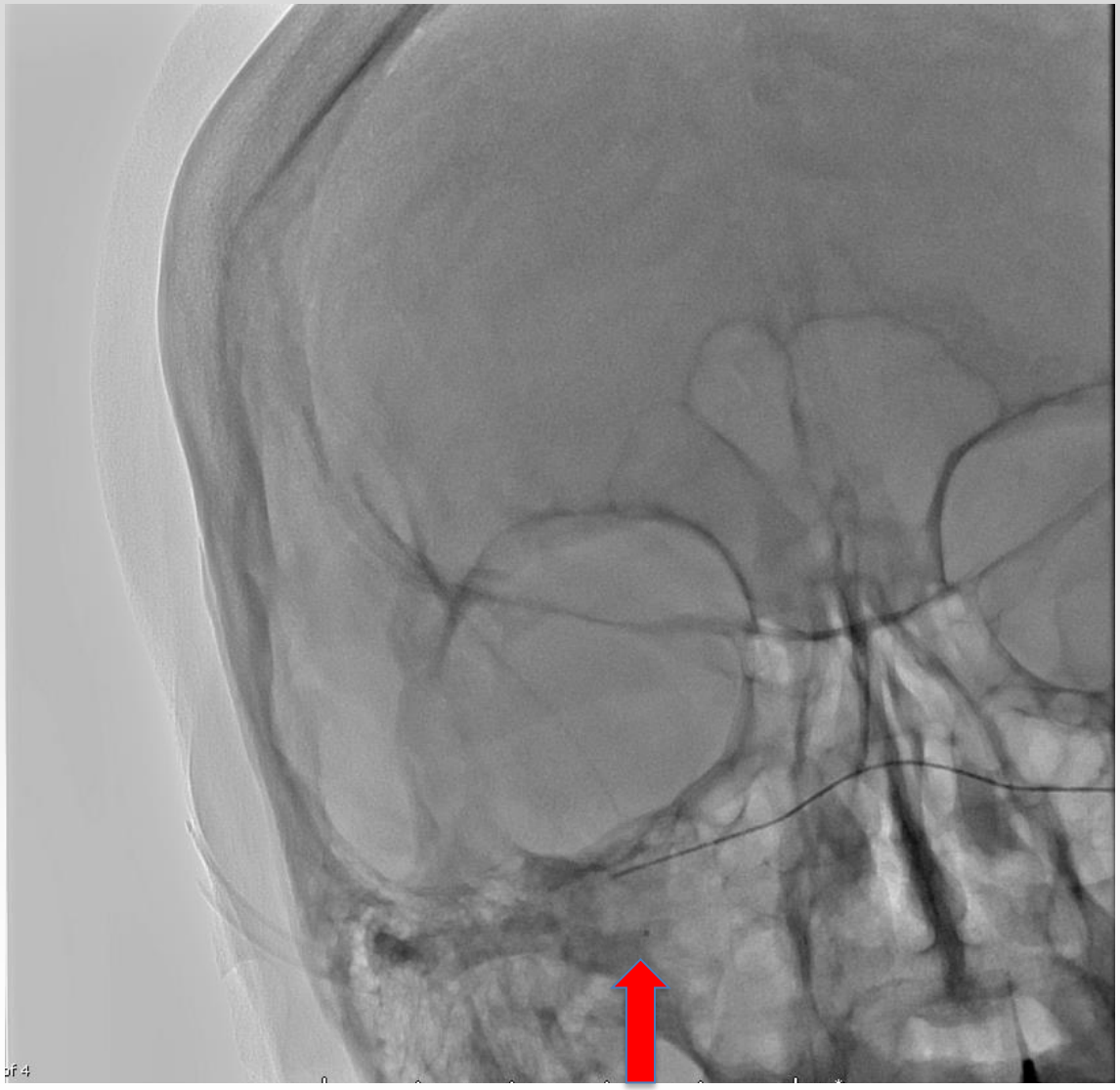
Left MMA Microcatheter Position at Foramen Spinosum



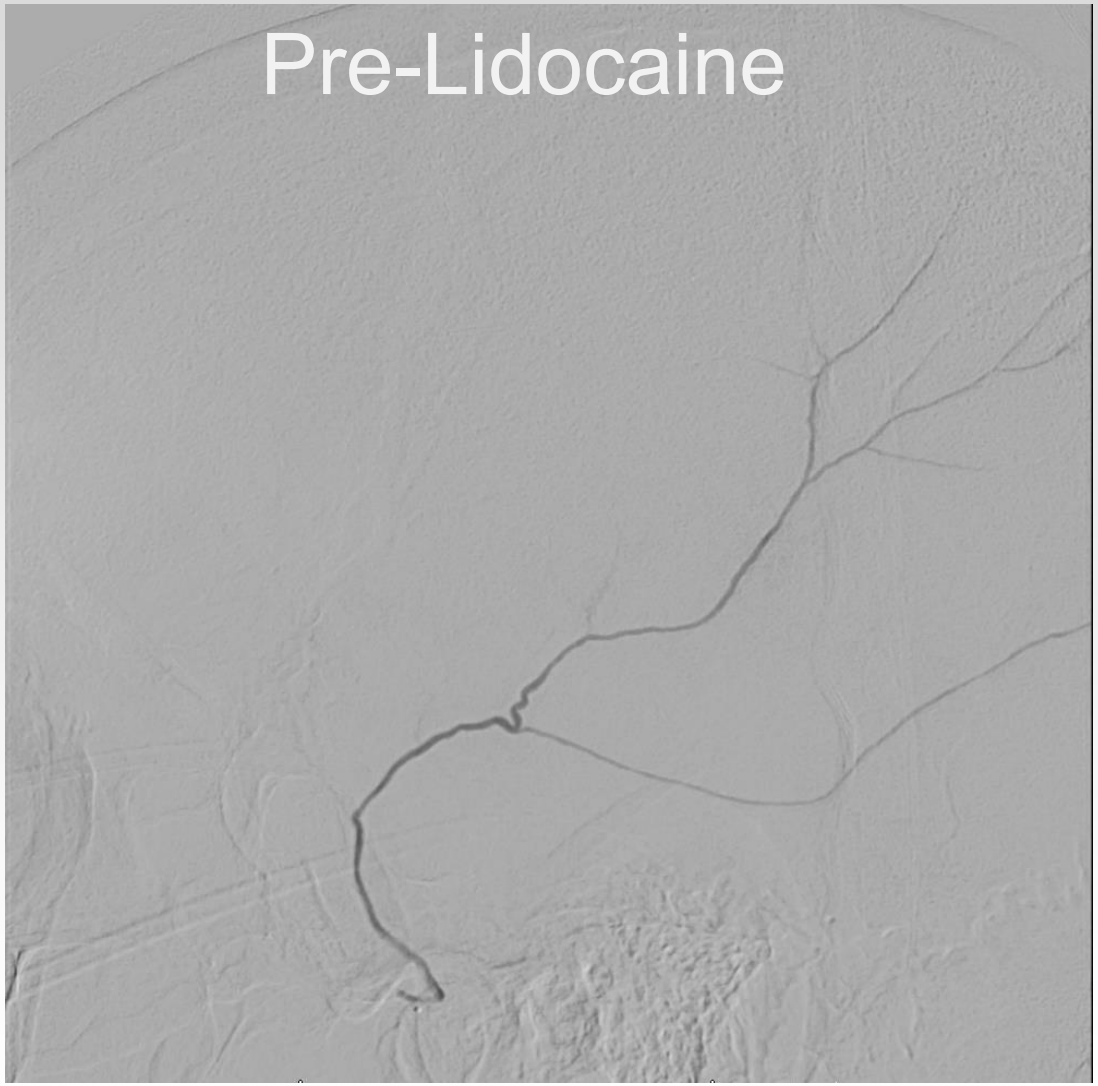
Left MMA Injection Pre and Post IA Lidocaine (50 mg)



Right MMA Microcatheter Position at Foramen Spinosum



Right MMA Injection Pre and Post IA Lidocaine (50 mg)



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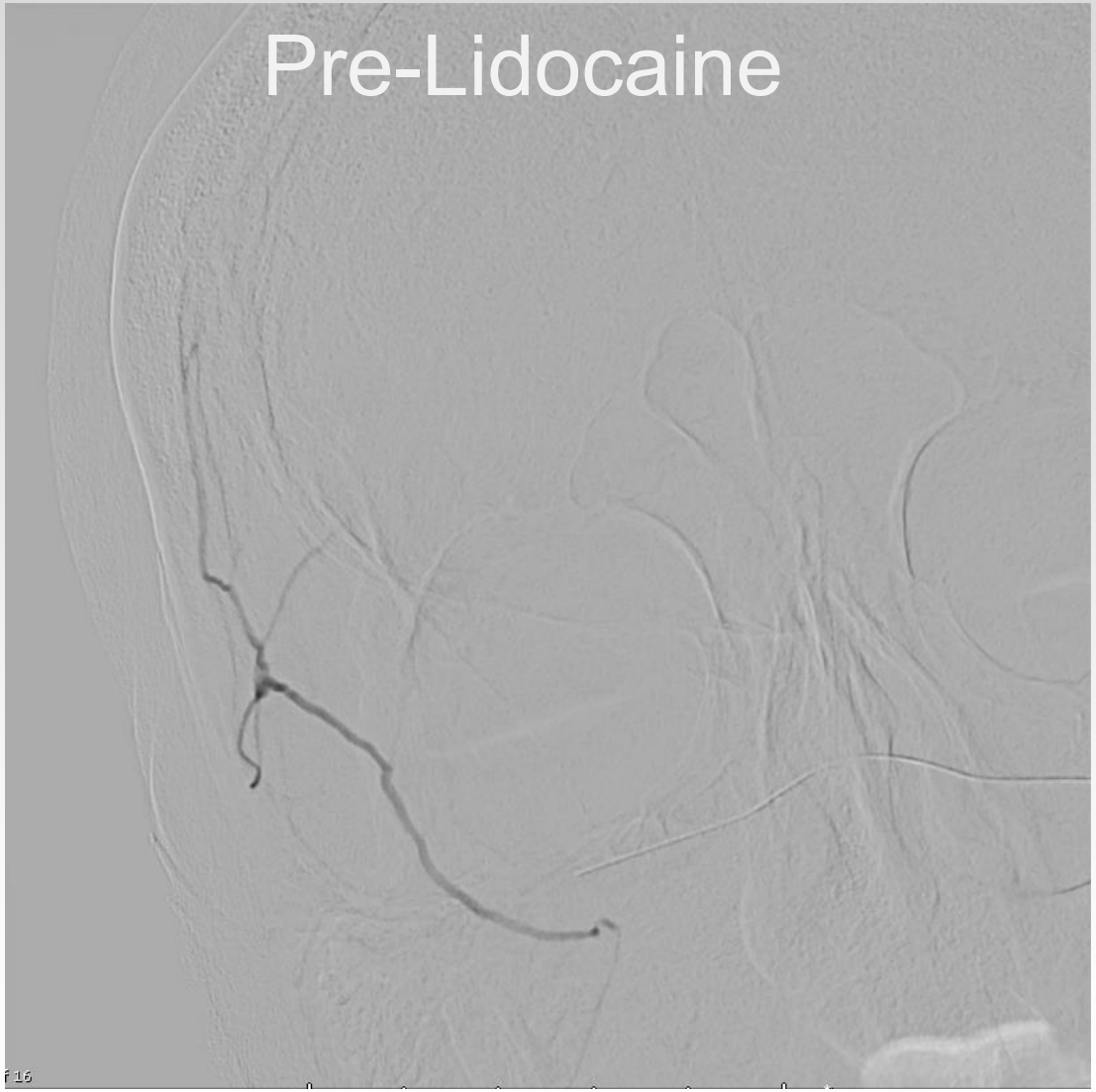


Followup

- Protracted: 4 weeks headaches free

Case 2 – Intra-arterial Lidocaine

59yo female w/ history of migraines who presented for diagnostic cerebral angiogram and IA lidocaine to rule out RCVS and vasospasm.

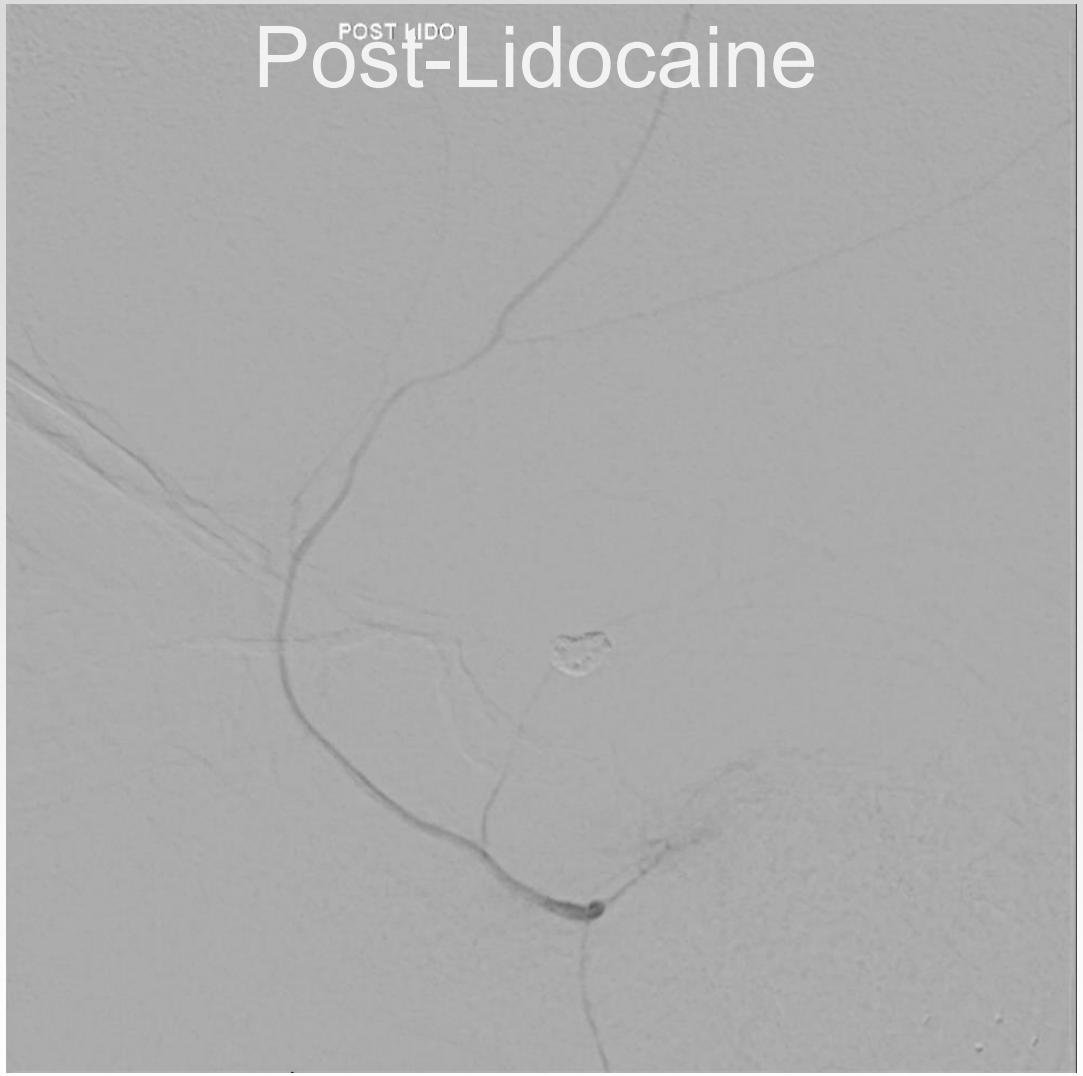
- Patient's headaches has been managed with neurosurgery in which workup including LP revealed an opening pressure of 35. Patient was trialed on acetazolamide in which headaches have been refractory and was recommended lumboperitoneal shunting. Continued symptoms and elevated opening pressures at follow up was managed with right TSJ stenting with improvement in symptoms. Recent (1 month) history of a ruptured posterior communicating artery aneurysm s/p balloon-assisted coil embolization with continuing headaches.
- PMH: Depression, GERD, Obesity
- Social History: Ongoing smoking, alcohol and substance use
- Exam: Neurologically Intact.

- Given refractory headaches, patient recommended as candidate for chronic migraine study for neural stimulants. Patient recommended for DSA to rule out vasospasm and RCVS which is an exclusion criteria.

Left MMA Injection Pre and Post IA Lidocaine (50 mg)

Right MMA Injection Pre and Post IA Lidocaine (50 mg)

Right MMA Injection Pre and Post IA Lidocaine (50 mg)



Case 3 – Intra-arterial Lidocaine with Middle Meningeal Artery Embolization

- A female in her sixth decade presented with a 12-year history of severe, medically refractory left-sided migraines that started after aneurysmal SAH.
  - 9/10 intensity with over 25 migraine days per month
  - Failed multimodal pain regimen and multiple rounds of Botox injections/trigger point therapy without relief

Relevant past medical history

- 12 years ago - Subarachnoid hemorrhage from a ruptured right internal carotid artery terminus aneurysm treated with primary coil embolization with excellent clinical recovery. Aneurysm residual treated with flow diversion at two years.

- 11 years ago - Asymptomatic unruptured left internal carotid artery supraclinoid segment aneurysm treated with flow diversion.

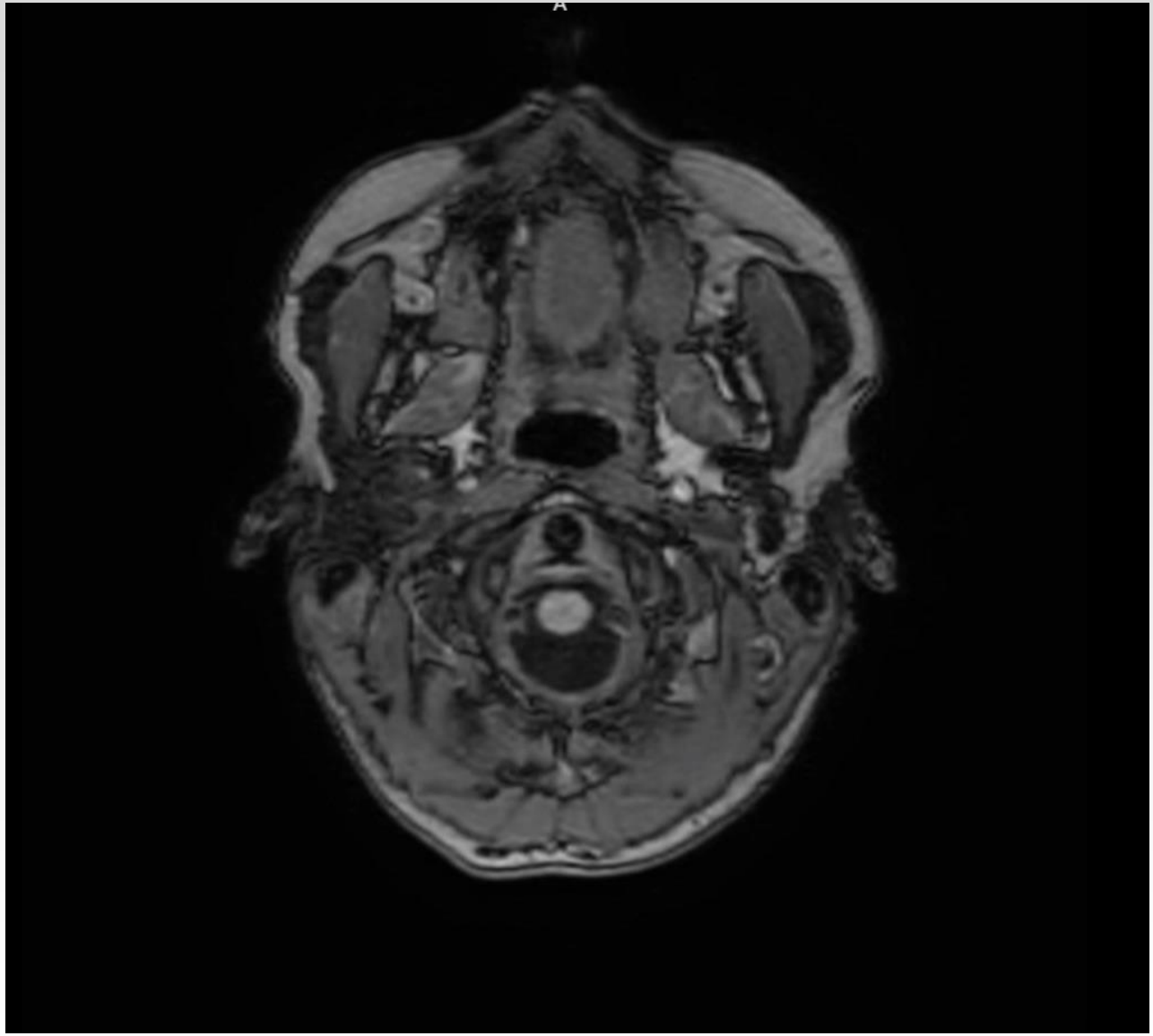
- 3 years ago - Asymptomatic unruptured left internal carotid artery terminus aneurysm treated with left pterional craniotomy surgical clip reconstruction of the bilobed aneurysm.

Neurological examination

- Neurologically intact

Neuro-Imaging findings

- No evidence of acute process on MRI. Stable post-operative findings from prior left craniotomy and right external ventricular drain tract. No evidence of residual or recurrent aneurysm on vessel imaging

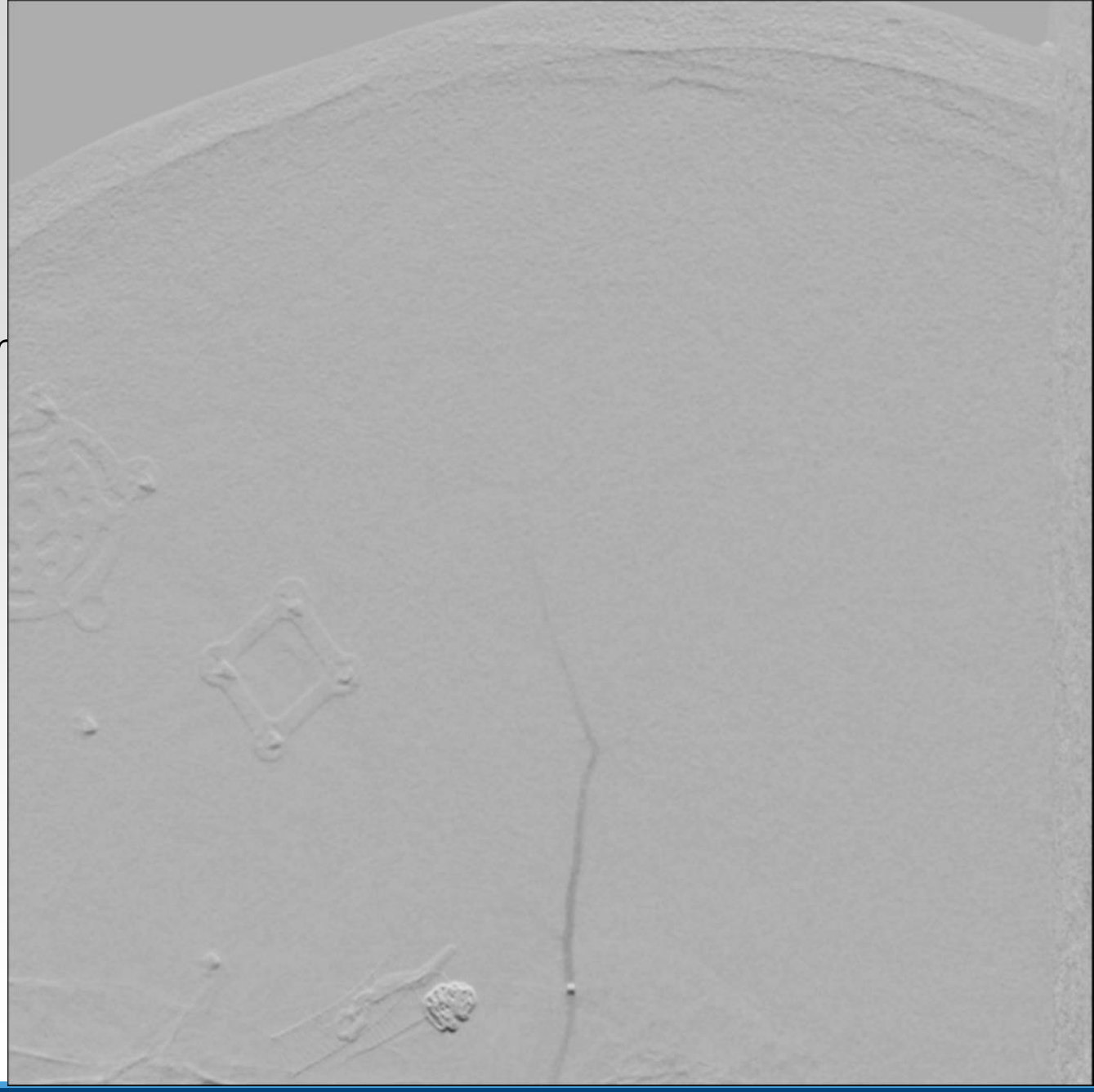


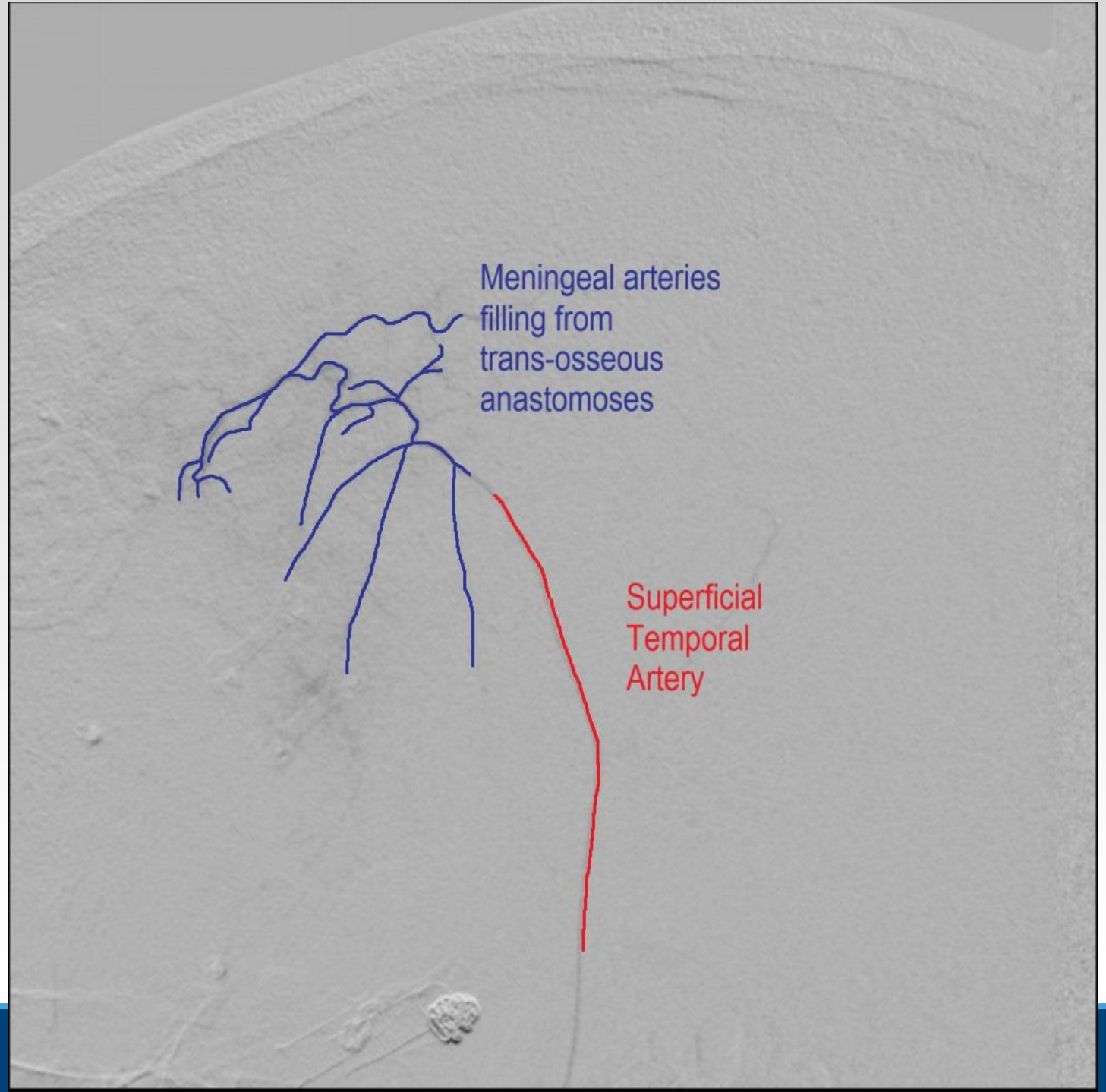
Left External Carotid Artery Injection

- Primary MMA trunk from IMA occluded s/p craniotomy
- Identification of the distal MMA arising from a terminal branch of the superficial temporal artery (STA)
- The intracranial MMA was noted by the linear deeper vessels running in the intracranial space
- STA to MMA trans-osseous anastomosis
- Microcatheterization of the intracranial MMA

Left External Carotid Artery Injection

- Identification of the distal MMA arising from a terminal branch of the superficial temporal artery (STA)
- The intracranial MMA was noted by the linear deeper vessels running in the intracranial space
- STA to MMA trans-osseous anastomosis
- Microcatheterization of the intracranial MMA




Meningeal arteries
filling from
trans-osseous
anastomoses
Superficial
Temporal
Artery

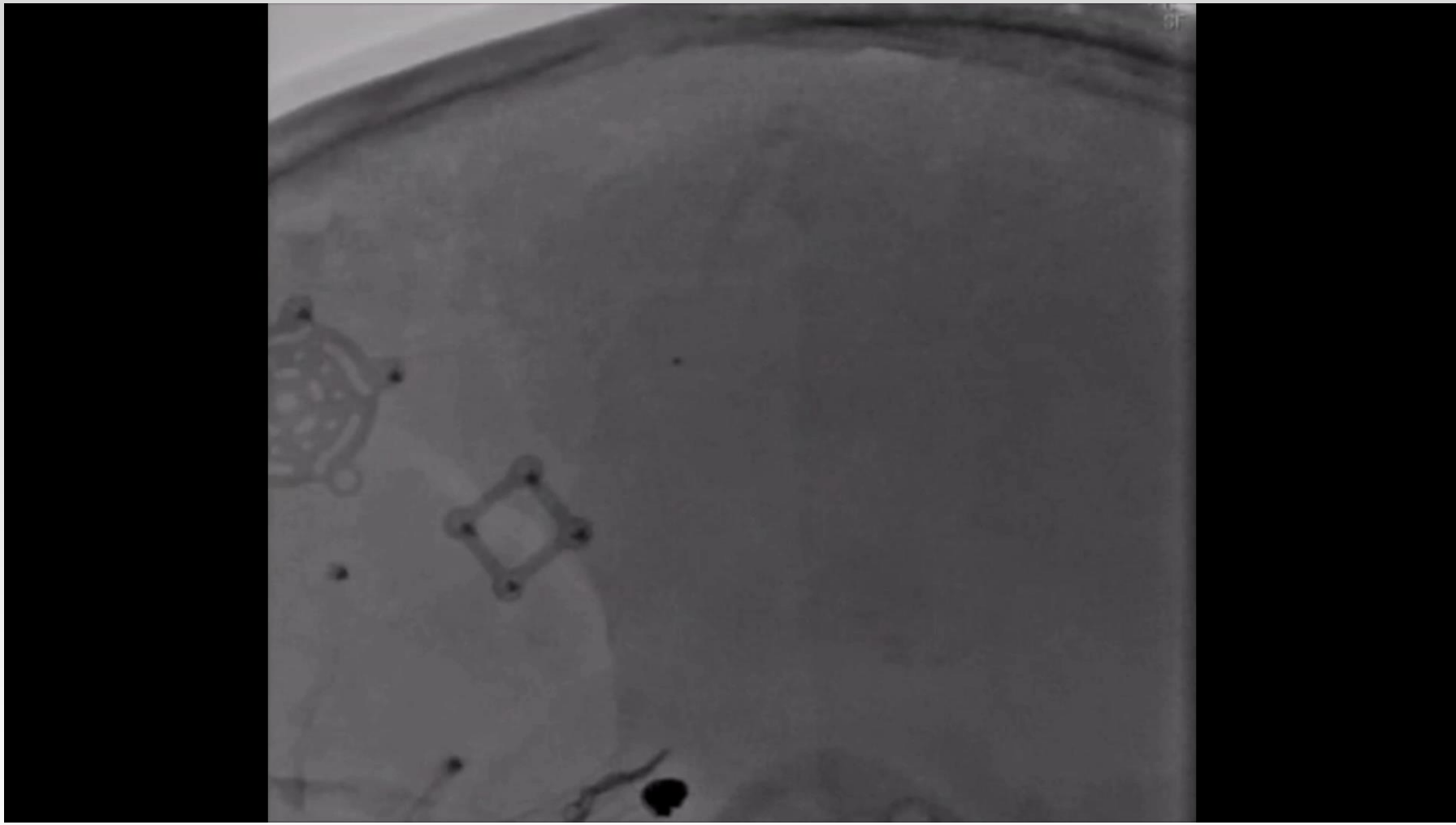
Lidocaine injection

- After obtaining a repeat neurologic examination on the table, 50 mg of lidocaine was slowly injected through the Headway Duo 167 into the distal frontal MMA branch

- Patient reported instantaneous near total resolution of her left sided headache. No new neurological deficits were appreciated

Onyx embolization

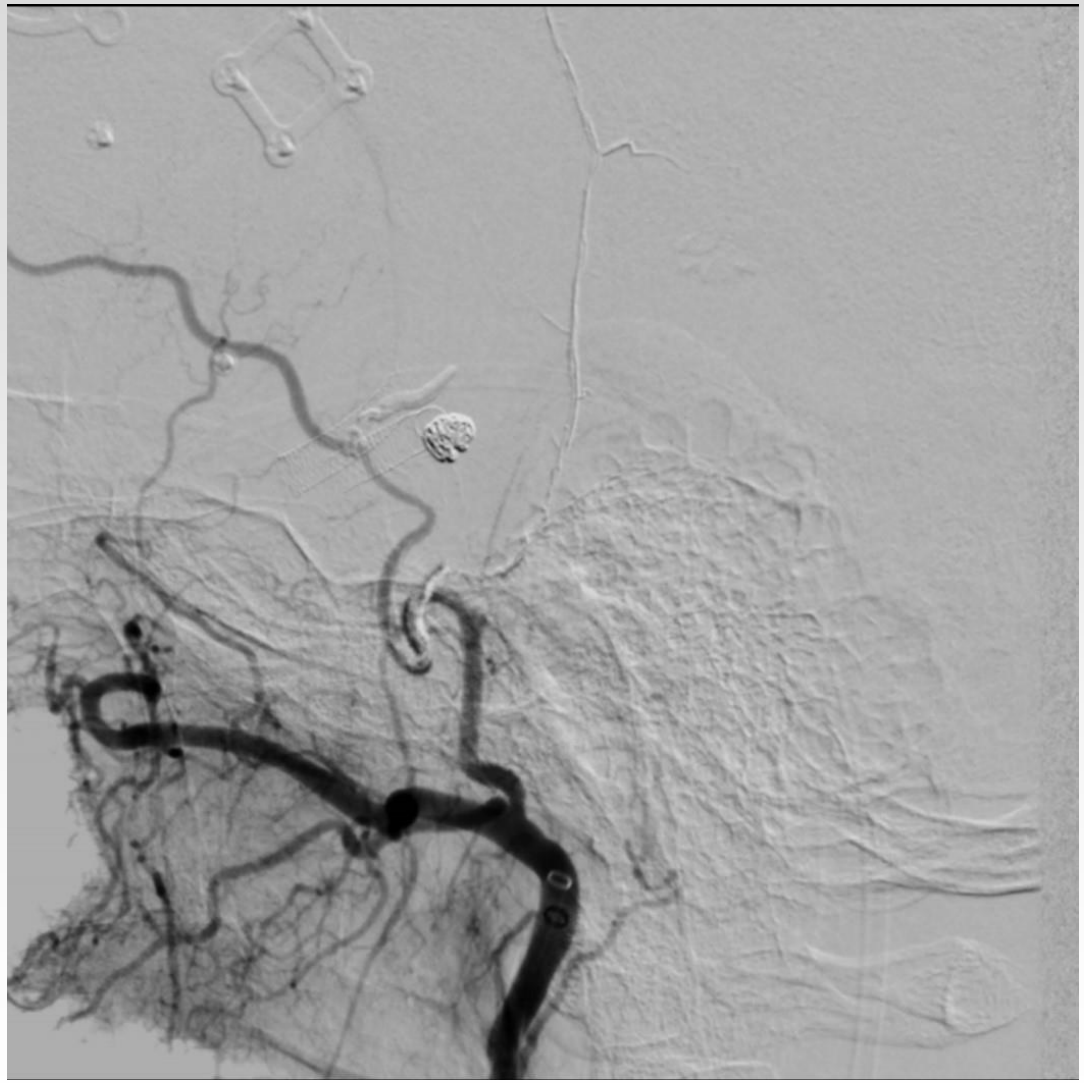
- DMSO injected to fill the dead space of the Headway 167 catheter
- Onyx 18 injected into the frontal branch of the MMA
- Reflux noted into the proximal STA



Post-Onyx embolization

- Onyx was seen to penetrate the dural branches of the MMA

- A small amount of reflux was noted into the proximal STA



The patient tolerated the procedure well without issue

- Patient continued to report complete resolution of the left sided migraine headache
- She endorsed mild left sided scalp soreness that improved overnight
- She was monitored overnight in the hospital
- No new or progressive neurological deficits were noted
- She was discharged home on post-procedure day 1

Advanced Treatment Approach

Intra-arterial Lidocaine Injection and Middle Meningeal Artery Embolization with Onyx for Relief of Refractory Migraine

Follow-up Outcome

- Patient continued to report complete resolution of her migraines at 1 month and 4 months following procedure
- MIDAS Score of 0 at 4 months
- 0 migraines per day for 4 months
- At one month follow-up, she did develop a left sided scalp eschar in the temporal region along with mild hair loss
- This was managed with local wound care and hyperbaric oxygen therapy without need for surgical intervention
- This resolved entirely by 120 days post procedure

Conclusion

- Chronic primary intractable headaches such as Migraines maybe amenable to endovascular intervention

- Onyx embolization work for chronic subdural hematoma but maybe problematic in the vicinity of the foramen spinosum for headaches

- IA lidocaine for MMA can surprisingly provide long term headache relief

- Vascular vasoconstriction may be related to symptomatic relief.


Thank You