

Middle Meningeal Artery Embolization

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Subdural Hematoma

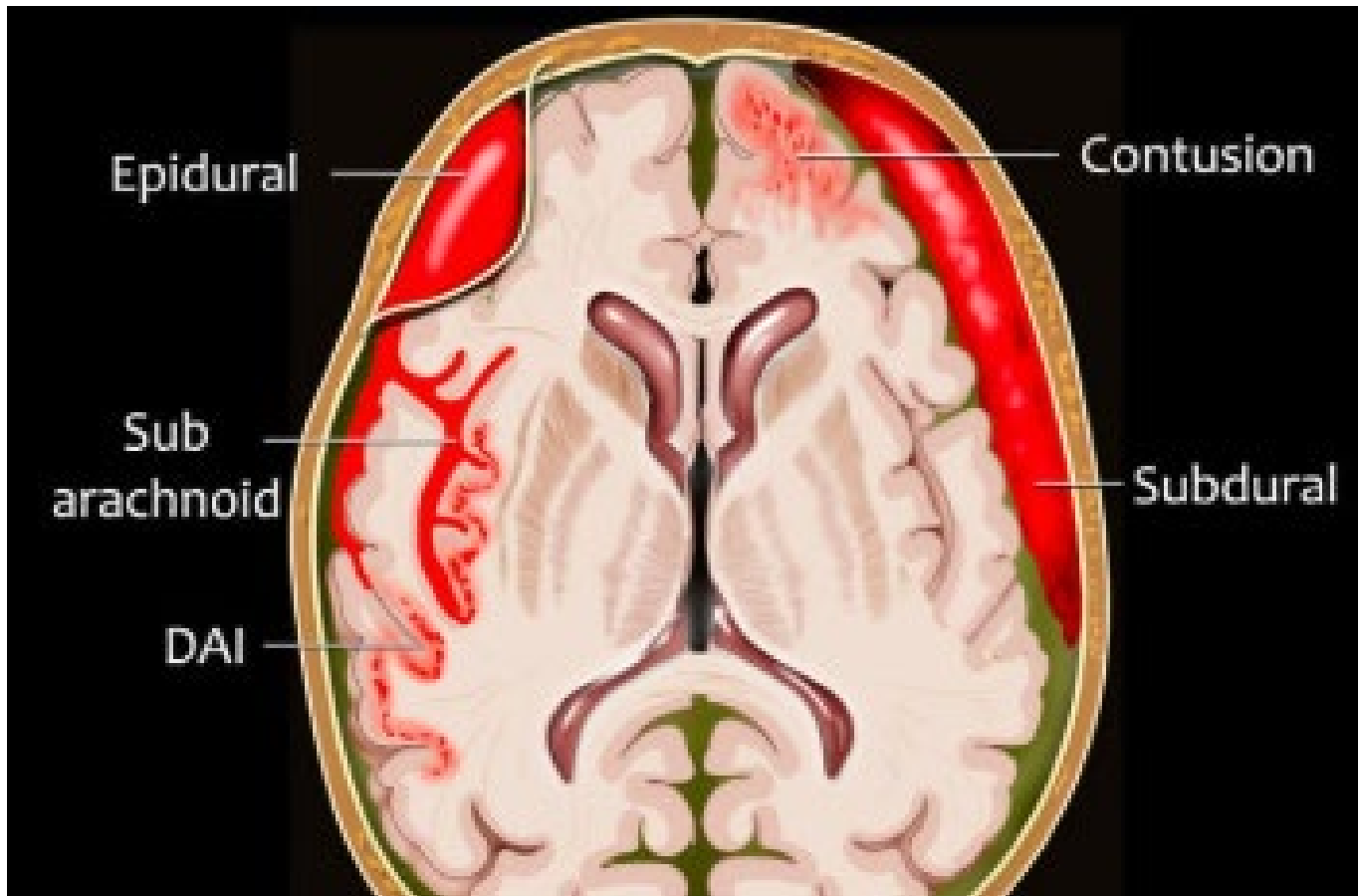
Chronic subdural hematoma is one of the most common cranial surgical conditions

For symptomatic cases, traditional treatment is surgical

Recurrence rate is 20-40%

At least 20% of post-op patients have poor outcomes requiring long term treatment

SUBDURAL HEMATOMA



SUBDURAL HEMATOMA

- 1658, JJ Wepfer described chronic subdural hematoma
- Necropsy on a stroke patient
- 1857, Virchow described it as 'pachymeningitis hemorrhagica interna'
- Gave an inflammatory process explanation

SUBDURAL HEMATOMA

- 'Chronic subdural hematoma' term used by Putnam and Cushing in 1925
- 1976, Labadie and Glover injected dex into rats
- Showed inhibited membrane formation
- More evidence that there is an inflammatory process involved

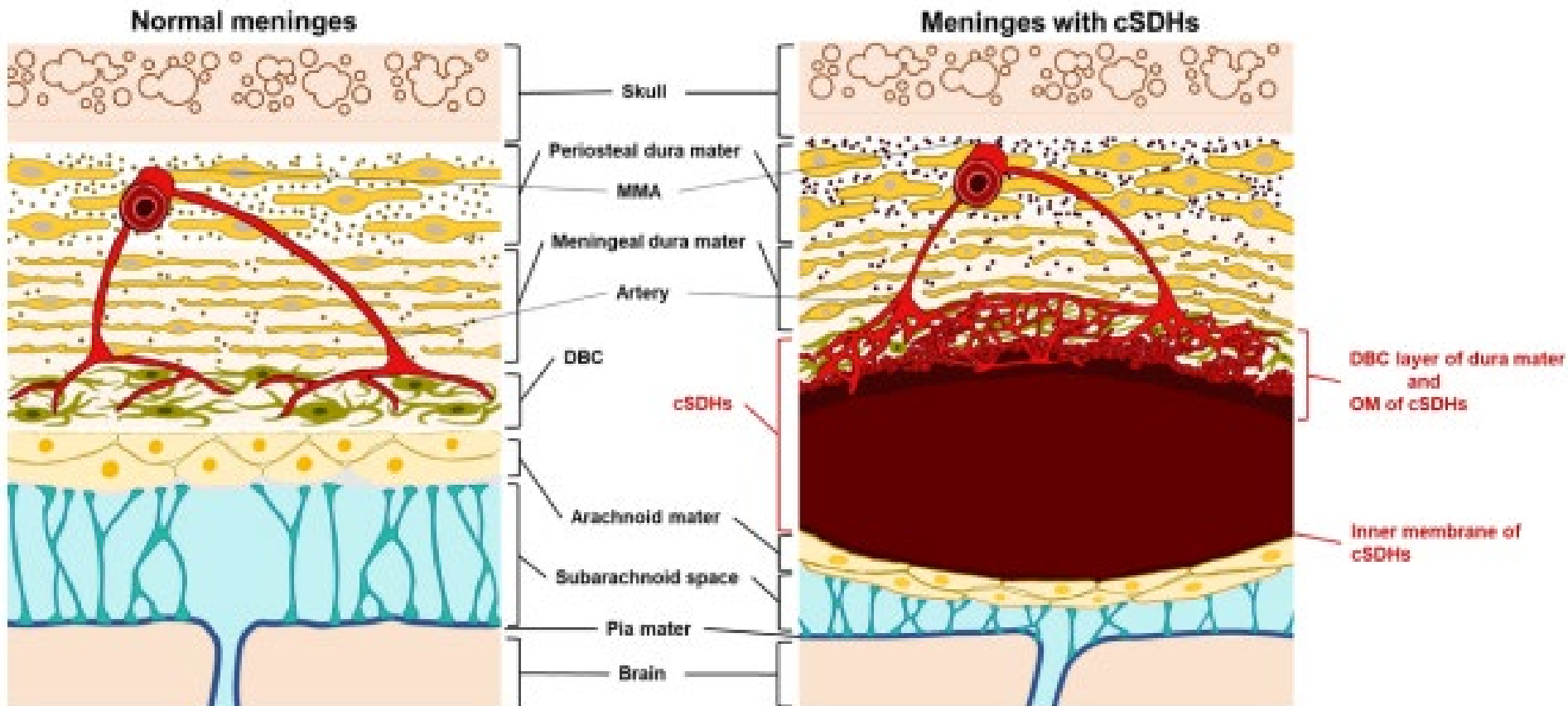
SUBDURAL HEMATOMA

- Traditional teaching: SDH originated from rupture of cortical bridging veins
- However, hematomas are often located away from sagittal sinuses
- New theory describes continuous cycle
- Chronic inflammation and neovascularization
- Following an inciting injury to dural border cells

SUBDURAL HEMATOMA

- Cascade of cell proliferation, macrophage infiltration, granulation formation
- Membranes form, body intermittently leaks blood
- Angiogenesis, anastomotic channels with MMA
- These new vessels are friable and leak into the subdural space
- Expansion when accumulation of blood outpaces resorption

SUBDURAL HEMATOMA



MMA EMBOLIZATION

- MMA embolization for chronic SDH first described in 2000
- Contrast seen in subdural space of post-embo CT scan
- Cornell group (Knopman et al), 2018 case series
- Only recently have we had good prospective data

MIDDLE MENINGEAL ARTERY

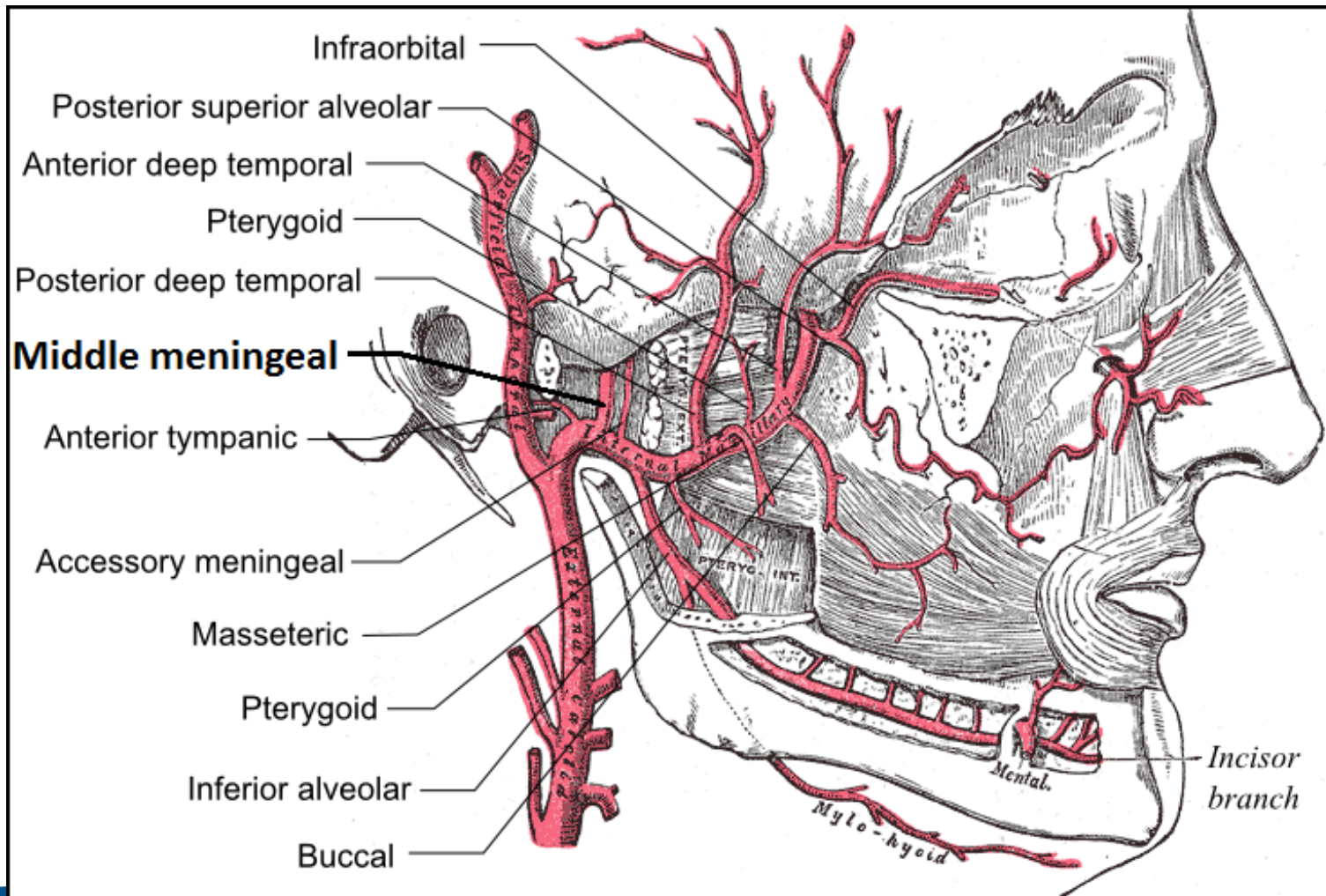


Table 2:

Different types of OA origin of the MMA^a

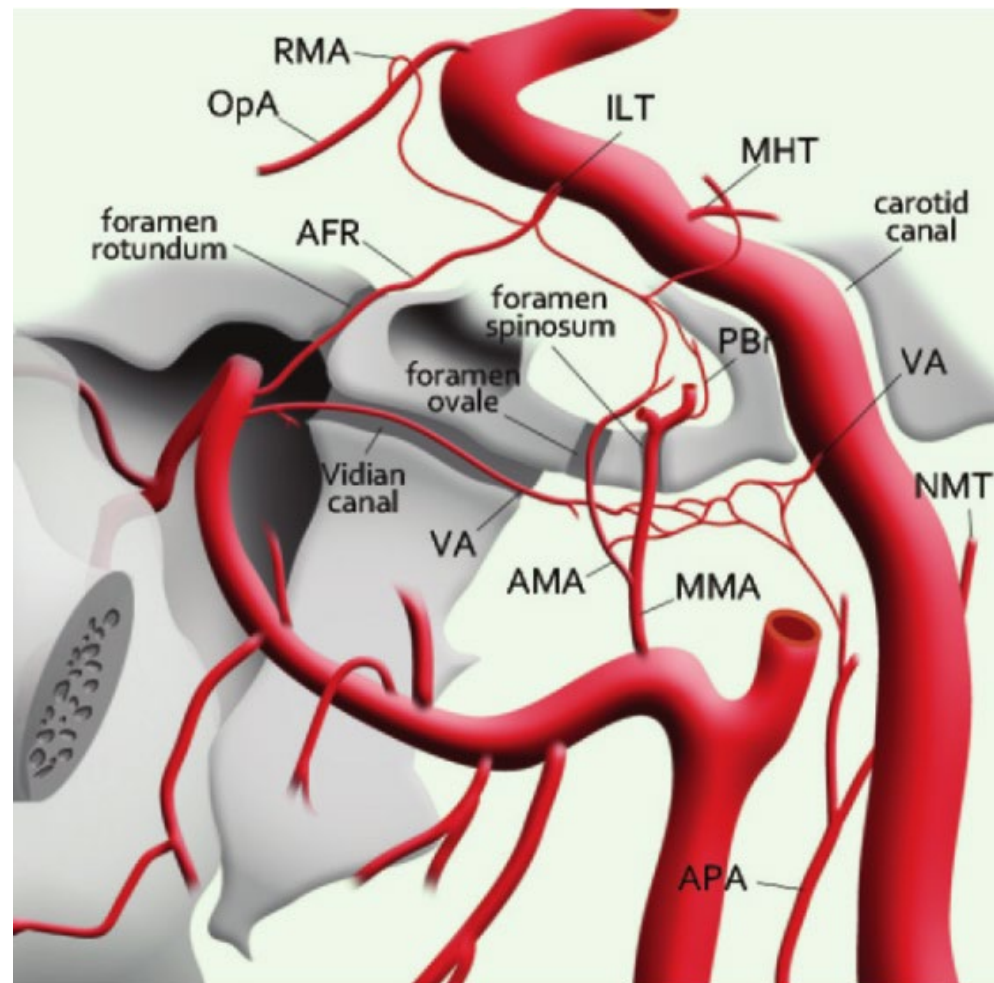
Type	Vascular Anatomy	Foramen Spinosum
I	Complete OA origin of the MMA	Absence
II	Partial OA origin of the MMA; anterior division from the OA; posterior division from the IMA	Reduced in size
III	OA origin of the accessory meningeal artery	Normal

^aFrom Ref.²⁸

Table 3:

Different branches of the MMA with their respective anastomosis

MMA Branches	Origin from the MMA	Territory (Dural and Neural)	Possible Anastomosis
Petrosal branch	Foramen spinosum	Trigeminal ganglion and nerves; posteromedial floor of the middle fossa; insertion of tentorium (medial half); superior petrosal sinus	Ascending pharyngeal artery (carotid branch); medial and lateral tentorial arteries (ICA)



Drawing illustrates potential anastomoses between branches of the maxillary artery, the ascending pharyngeal artery (APA), and the ICA. Remnants of the second aortic arch can form the Vidian anastomotic system, consisting of the Vidian artery (VA) from the maxillary artery, the ICA, the AMA, and the pharyngeal branches of the ascending pharyngeal artery. AFR = artery of the foramen rotundum, ILT = inferolateral trunk, MHT = meningohypophyseal trunk, NMT = neuromeningeal trunk, OpA = ophthalmic artery, PBr = petrosal branch, RMA = recurrent meningeal artery.

EMBOLIC MATERIALS



RECENT TRIALS

- New England Journal of Medicine, Nov 2024
- Prospective, randomized
- All non-acute
- If emergency evacuation is needed, craniotomy or burr holes
- Adjunct to standard therapy

RECENT TRIALS

ORIGINAL ARTICLE

Embolization of the Middle Meningeal Artery for Chronic Subdural Hematoma

David Fiorella, M.D., Ph.D., Stephen J. Monteith, M.D.,
Ricardo Hanel, M.D., Ph.D., Benjamin Atchie, D.O., SoHyun Boo, M.D.,
Ryan A. McTaggart, M.D., Alois Zauner, M.D., Stavropoula Tjoumakaris, M.D.,
Charlotte Barbier, M.D., Ronald Benitez, M.D., Laurent Spelle, M.D.,
Laurent Pierot, M.D., Joshua A. Hirsch, M.D., Michael Froehler, M.D., Ph.D.,
and Adam S. Arthur, M.D., M.P.H., for the STEM Investigators*

RECENT TRIALS - STEM

- Symptomatic chronic subdural hematoma
- Symptoms: headache, cognitive decline, imbalance, neuro deficit
- Standard treatment (control) vs embolization adjunct
- Standard treatment: surgical or nonsurgical chosen before randomization

RECENT TRIALS - STEM

- Primary efficacy outcome:
 - Recurrent or residual ($>10\text{mm}$) SDH at 180 days
 - Reoperation or surgical rescue within 180 days
 - Major stroke, MI, death within 180 days
- Primary safety outcome:
 - Major stroke or death from any cause within 30 days

RECENT TRIALS - STEM

- 310 enrolled patients
- 149 embolization vs 161 control
- 189 received surgery (burr hole, seps, crani) vs
- 121 nonsurgical treatment
- Liquid embolic
- Mean age 73, 70% men

Table 3. Primary Efficacy Outcome (Intention-to-Treat Population).

Outcome	Embolization Group (N=149)	Control Group (N=161)	Effect with Observed Data		Effect with Imputed Data	
			Odds Ratio (95% CI)	P Value	Odds Ratio (95% CI)	P Value
	no. of patients with event/ total no. evaluated (%)					
Primary efficacy outcome	19/120 (16)	47/129 (36)	0.32 (0.17–0.59)	<0.001	0.36 (0.20–0.66)	0.001
Recurrent or residual chronic subdural he- matoma at 180 days	4/120 (3)	4/129 (3)	—	—	—	—
Reoperation or surgical rescue within 180 days	12/120 (10)	39/129 (30)	—	—	—	—
Major disabling stroke, myocardial infarc- tion, or death from neurologic causes within 180 days	3/120 (2)	4/129 (3)	—	—	—	—
Primary efficacy outcome according to stan- dard treatment strategy*						
Nonsurgical standard treatment	9/48 (19)	29/52 (56)	0.18 (0.07–0.45)	—	0.19 (0.08–0.46)	—
Surgical standard treatment	10/72 (14)	18/77 (23)	0.53 (0.23–1.24)	—	0.60 (0.27–1.35)	—

RECENT TRIALS - STEM

- Primary outcome event: 19/120 (16%) in embo group
- 47/129 (36%) in control, statistically significant
- Primary safety analysis:
 - 4/144 (3%) in embo group vs 5/166 (3%) in control
 - 8% embo vs 5% control died in 180 days (not significant)
 - 1% embo group vs 2% control group death due to neurological cause

RECENT TRIALS - STEM

- For symptomatic, chronic SDH...
- Adjunctive MMA embo resulted in lower risk of treatment failure
- No significant increase in disabling stroke or death
- Benefit driven by patients receiving nonsurgical standard treatment

EMBOLIC AGENTS

Safety and efficacy comparison of embolic agents for middle meningeal artery embolization for chronic subdural hematoma

Nathaniel R. Ellens¹, Derrek Schartz², Gurkirat Kohli¹, Redi Rahmani¹,
Sajal Medha K. Akkipeddi¹, Thomas K. Mattingly¹, Tarun Bhalla¹,
Matthew T. Bender¹

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²*Department of Imaging Sciences, University of Rochester Medical Center, New York, USA*

EMBOLIC AGENTS

- Early MMA embo series utilized particles and coils
- Widespread availability, low cost
- Many interventionalists now using liquid embolics
- Systemic review of MMA embo w/ different embolic agents

EMBOLIC AGENTS

- Particles function by aggregating and lodging distally within vasculature
- Different sizes
- Liquid embolic agents fill the entire vessel, require distal penetration
- Requires special catheters and often changing catheters

EMBOLIC AGENTS

- Liquid embolics can be pushed from a wedged position and is a permanent cast
- May be difficult to control
- Particles can degrade over time
- Liquid embolics can be much more expensive than particles

EMBOLIC AGENTS

- 31 articles were included
- Clinical outcomes were summarized
- Recurrence
- Need for surgical rescue or re-operation
- Periprocedural complications

EMBOLIC AGENTS

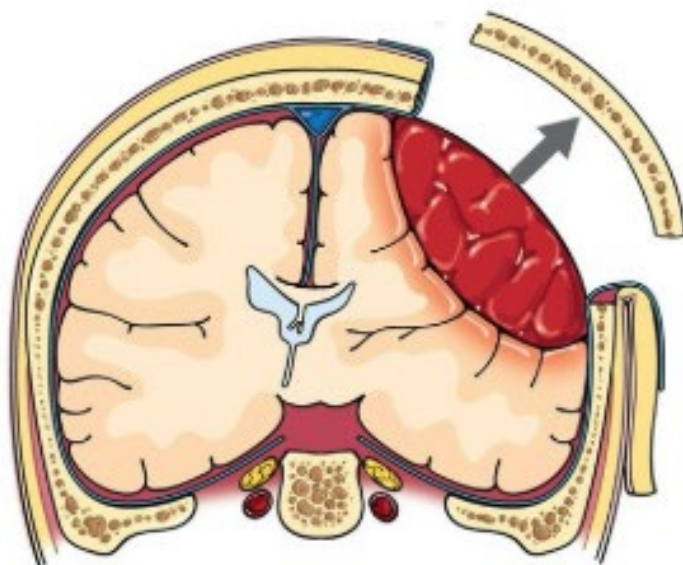
- No difference in recurrence rate (5.5% particles, 4.5% - 6.5% liquids)
- No difference in need for surgical rescue (5% particles, 4% - 6.9% liquids)
- No difference in procedural complications (1.8% particles, 1.6-3.6% liquids)

TRIALS SUMMARY

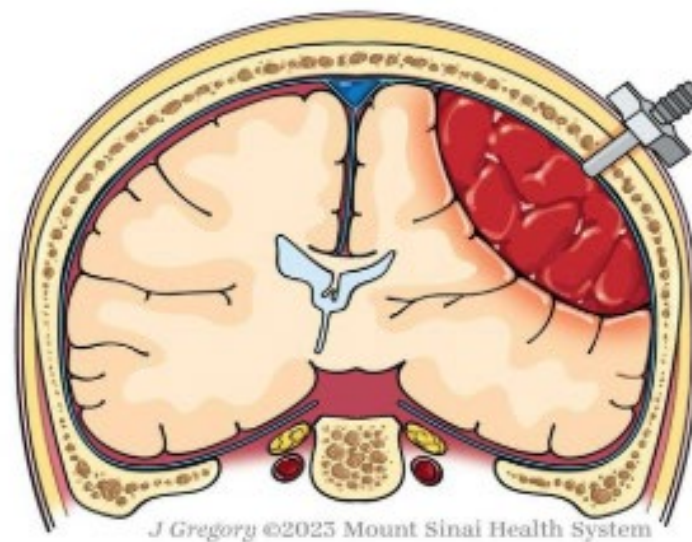
- MMAembo as an adjunct to standard treatment does provide some benefits
- MMA embo not currently indicated as replacement for surgery
- MMA embo not currently indicated for asymptomatic or acute SDH
- Future research: embolization material, exact location of embolization, subgroup populations



Craniotomy

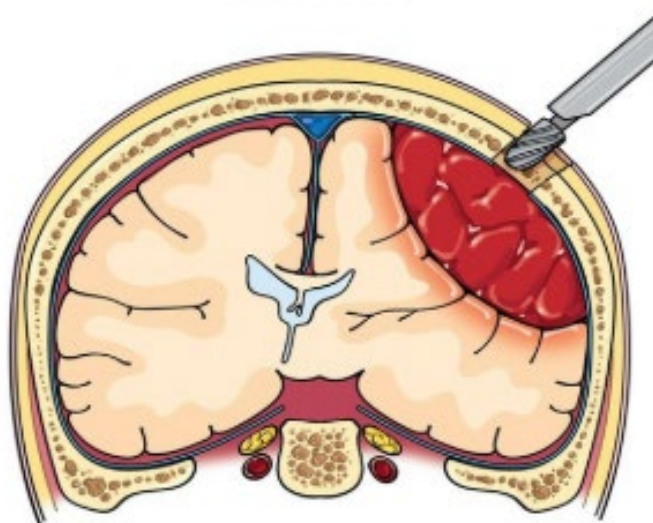


Twist Drill

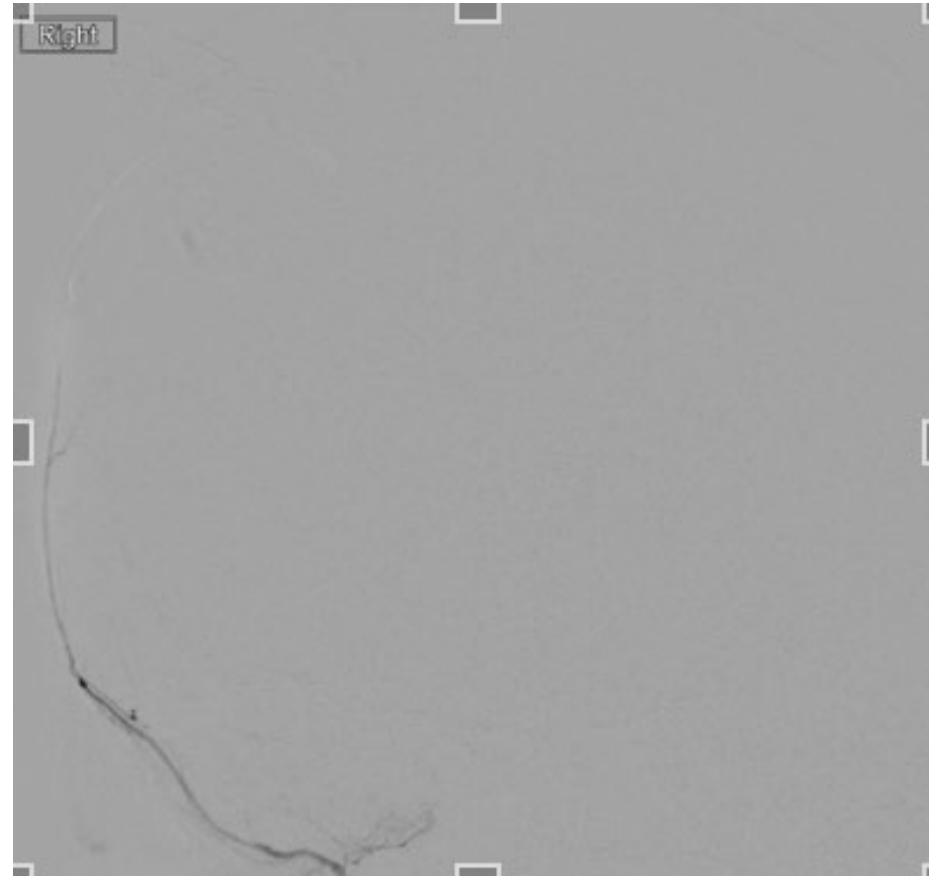
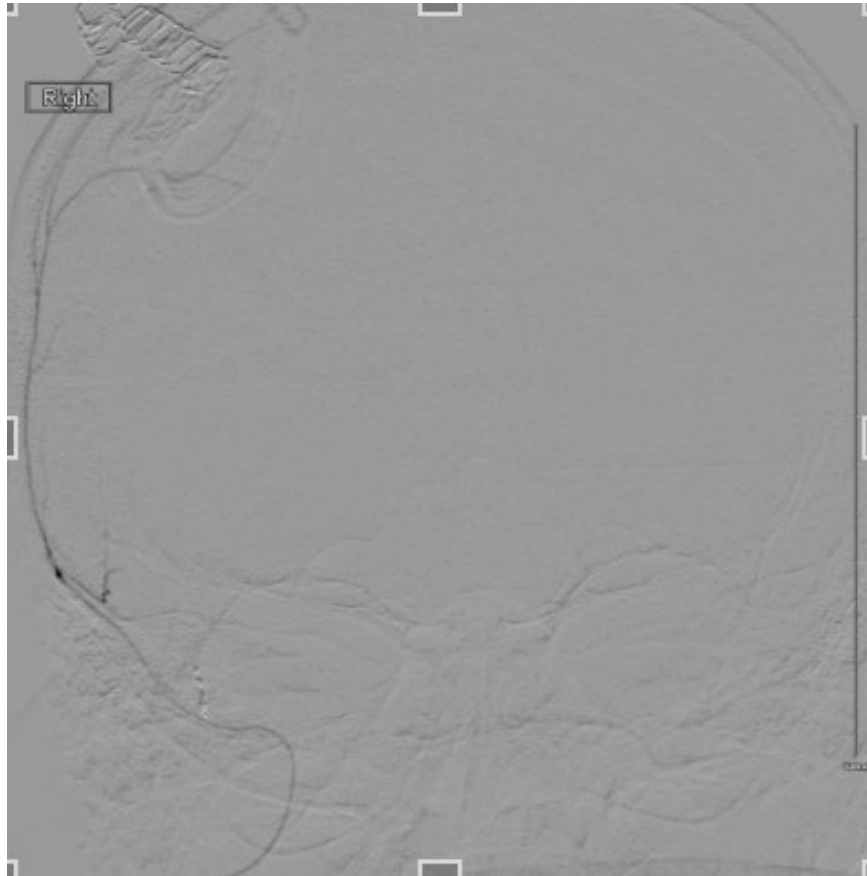


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Burr Hole



Back to our Case...



Back to our Case...



Thank you!
Any Questions