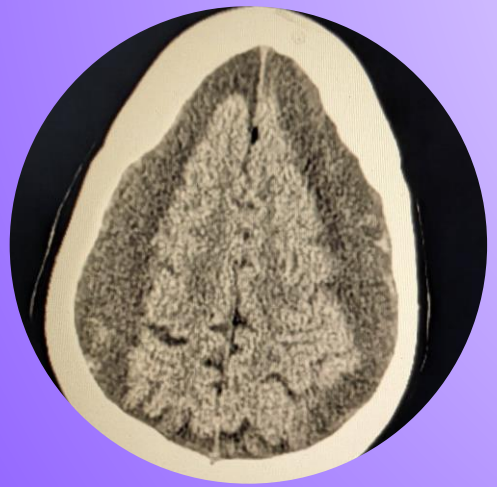
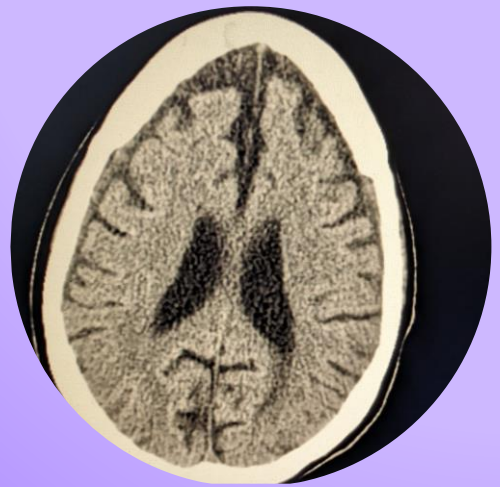




SUPERSELECTIVE MMA EMBOLIZATION FOR CHRONIC SUBDURAL HEMATOMA: A NEW TREATMENT PARADIGM?

Jeffrey E. Thomas, MD, FACS

Medical Director

Cerebrovascular and Neurointerventional Neurosurgery

SUPERSELECTIVE MMAE FOR CSDH: A NEW TREATMENT PARADIGM?

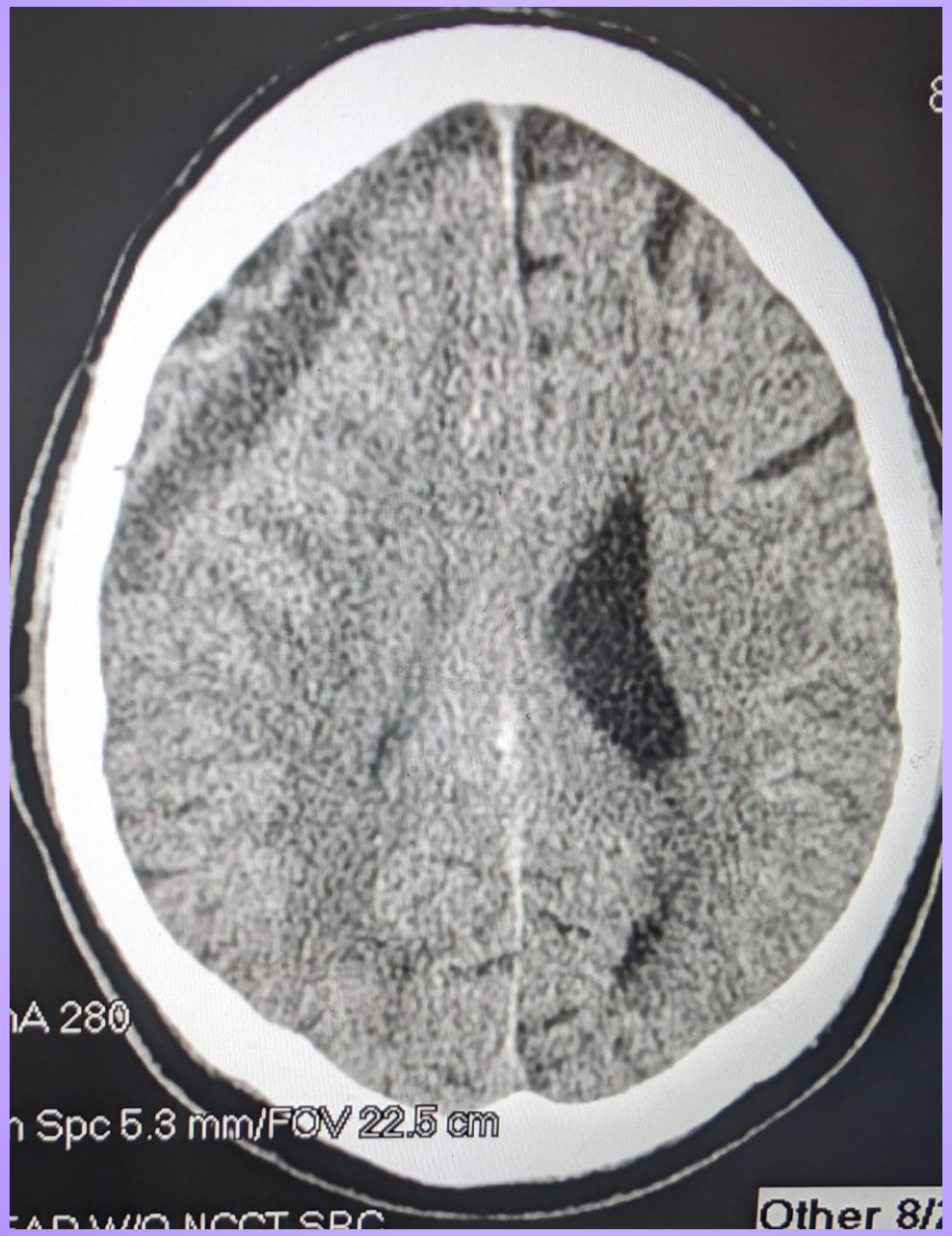
Chronic subdural hematoma: pathophysiology and treatment history

Intervention strategy: early investigations

Current neurointerventional method

Early results

Chronic Subdural hematoma



39.9/ 100,000

60,000 annually USA by 2030

J Neurosurg 54:637–645, 1981

Chronic subdural hematomas: a review

THOMAS-MARC MARKWALDER, M.D.

Department of Neurosurgery, University of Bern, Bern, Switzerland

✔ Present knowledge of the still controversial pathogenetic, ultrastructural, diagnostic, and treatment aspects of chronic subdural hematomas is reviewed.

KEY WORDS • **subdural hematoma** • **neomembrane** • **cerebrospinal fluid** • **experimental hematoma** • **ultrastructural study** • **computerized tomography**

SINCE the detailed description of pachymeningitis hemorrhagica interna by Virchow in 1857,[136] the pathophysiological, ultrastructural, diagnostic, and management aspects of chronic subdural hematomas (SDH's) have remained controversial. The aim of this article is to elaborate the present state of knowledge of chronic SDH in order to remind the practicing neurosurgeon of the principles that are

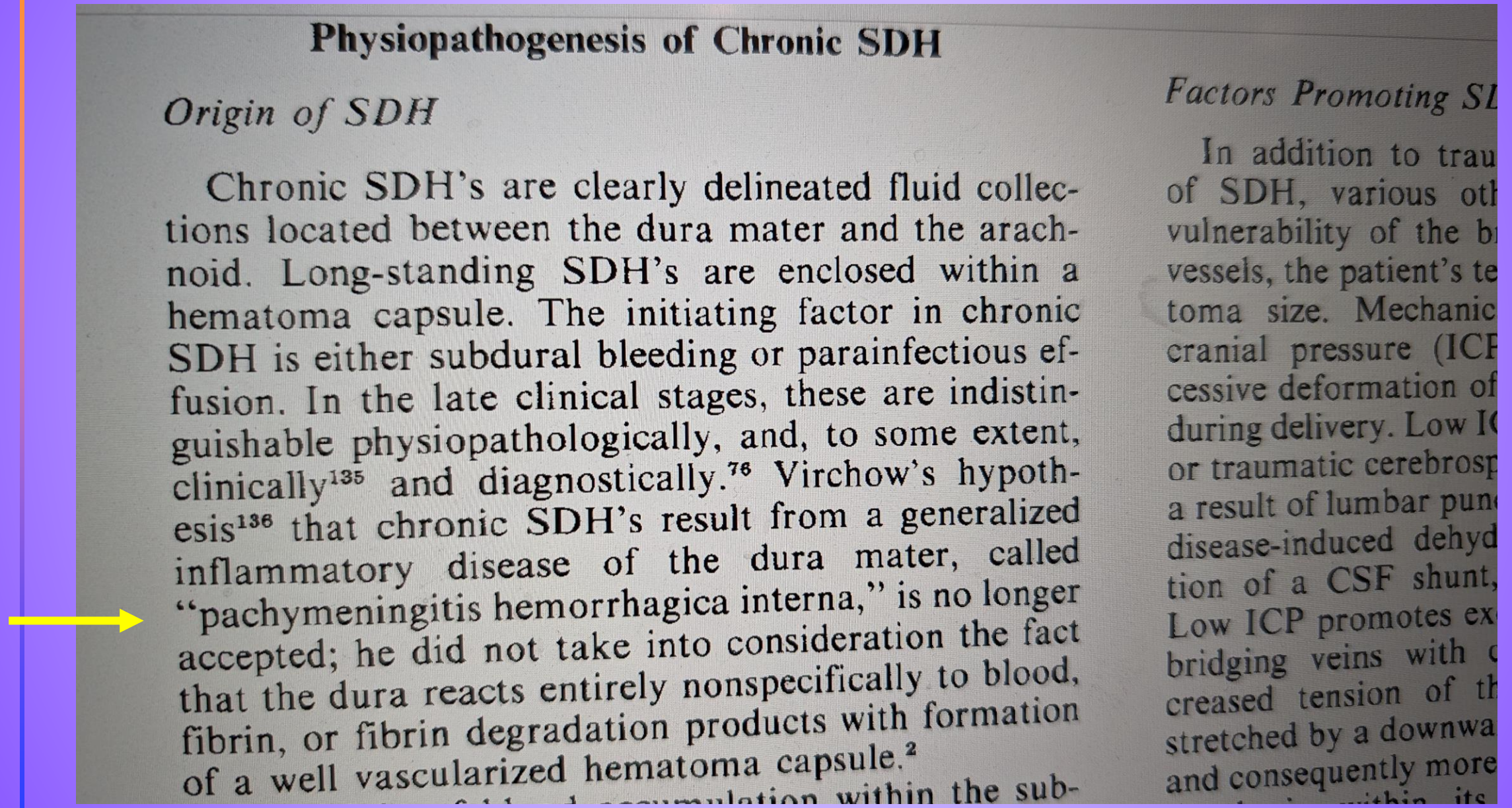
of the cortex and the arachnoid,[51] in fractures of the skull with tearing of the adjacent dura as well as lacerations of the venous sinuses,[67] and in traumatized arachnoid cysts.[71,119] Nontraumatic origins of subdural blood or fibrin accumulation are convexity arteriovenous malformations and aneurysms,[5,11,30,113] other cerebrovascular lesions, hemorrhagic diathesis, infectious diseases,[76,122,138] brain tumors,[88] especially

Pathophysiology 1857

Physiopathogenesis of Chronic SDH

Origin of SDH

Chronic SDH's are clearly delineated fluid collections located between the dura mater and the arachnoid. Long-standing SDH's are enclosed within a hematoma capsule. The initiating factor in chronic SDH is either subdural bleeding or parainfectious effusion. In the late clinical stages, these are indistinguishable physiopathologically, and, to some extent, clinically[135] and diagnostically.[76] Virchow's hypothesis[136] that chronic SDH's result from a generalized inflammatory disease of the dura mater, called "pachymeningitis hemorrhagica interna," is no longer accepted; he did not take into consideration the fact that the dura reacts entirely nonspecifically to blood, fibrin, or fibrin degradation products with formation of a well vascularized hematoma capsule.[2]

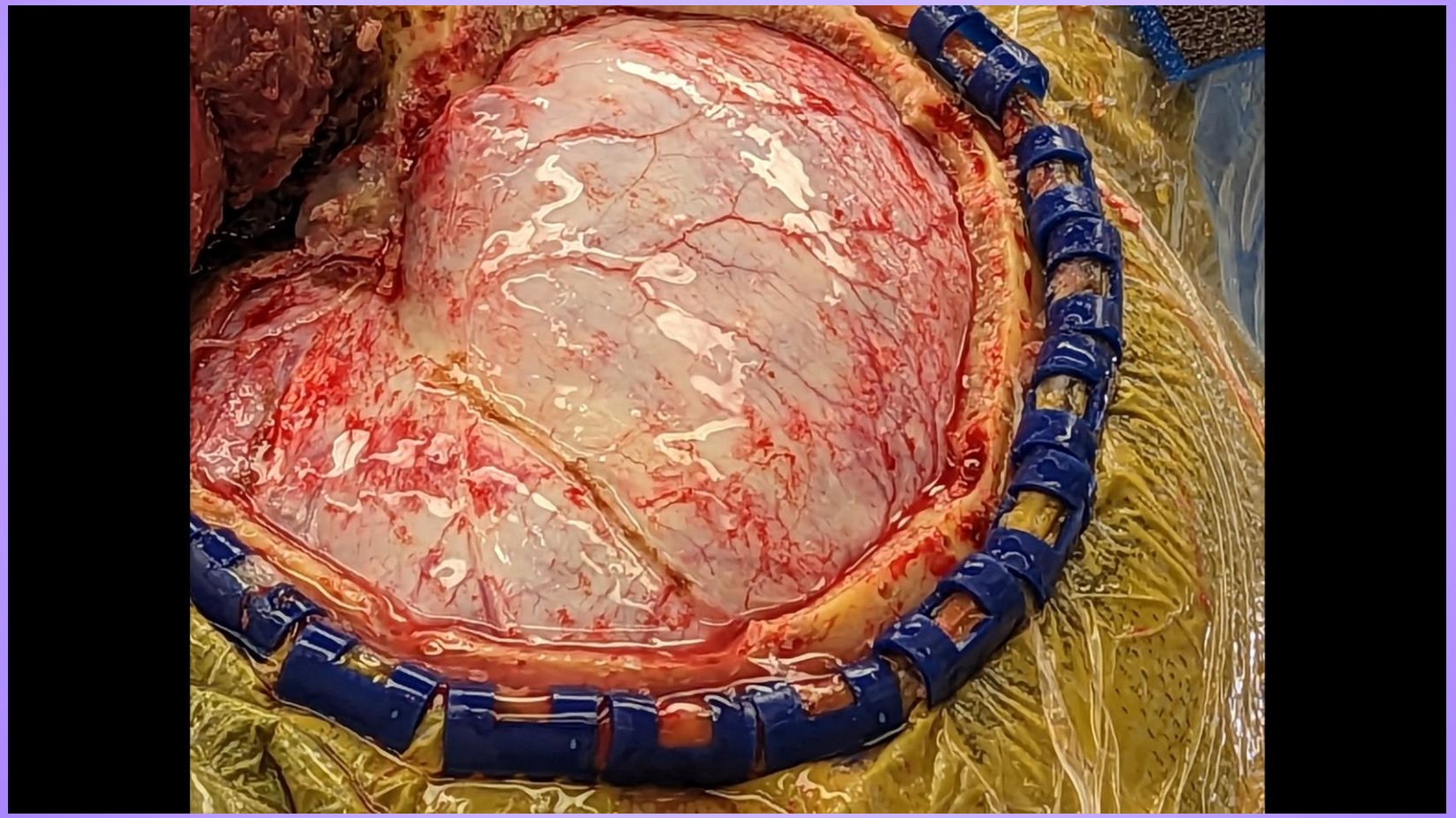


Factors Promoting SD

In addition to trau
of SDH, various oth
vulnerability of the b
vessels, the patient's te
toma size. Mechanic
cranial pressure (ICP
cessive deformation of
during delivery. Low IC
or traumatic cerebrosp
a result of lumbar punc
disease-induced dehyd
tion of a CSF shunt,
Low ICP promotes ex
bridging veins with c
creased tension of th
stretched by a downwa
and consequently more

OPERATION

OPERATION



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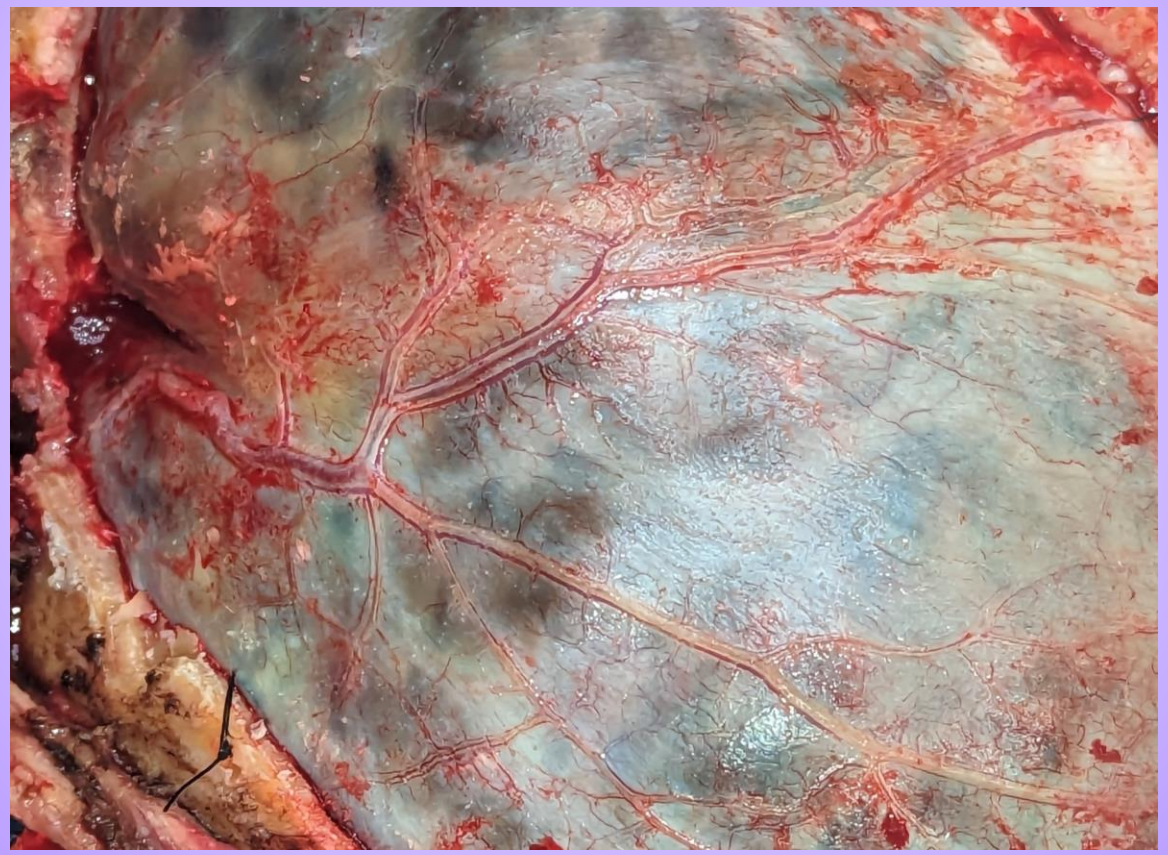
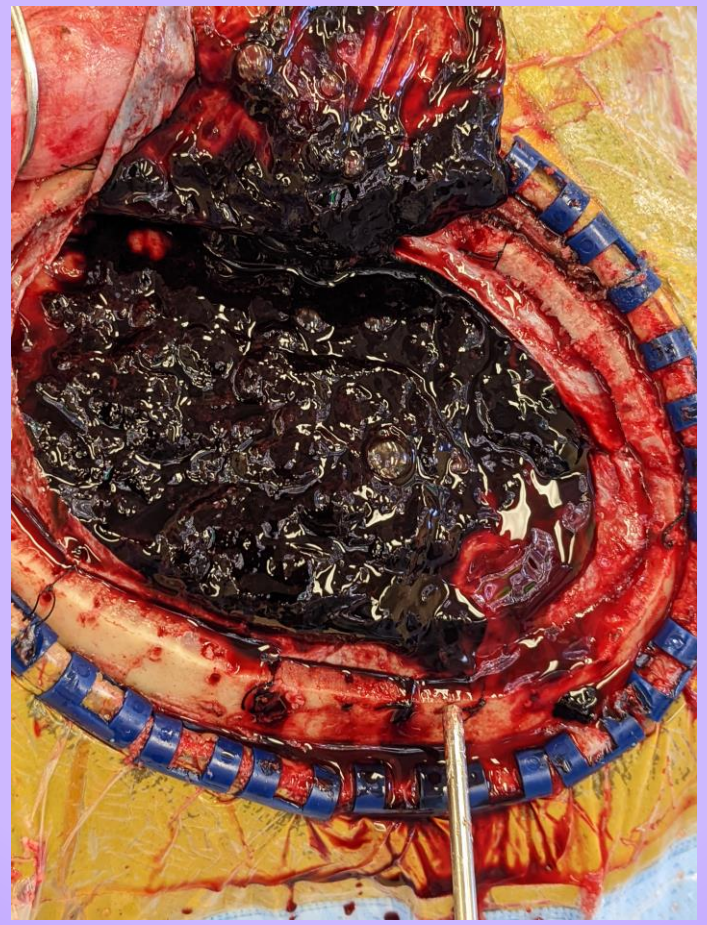


OPERATION: ICP elevation

MMA



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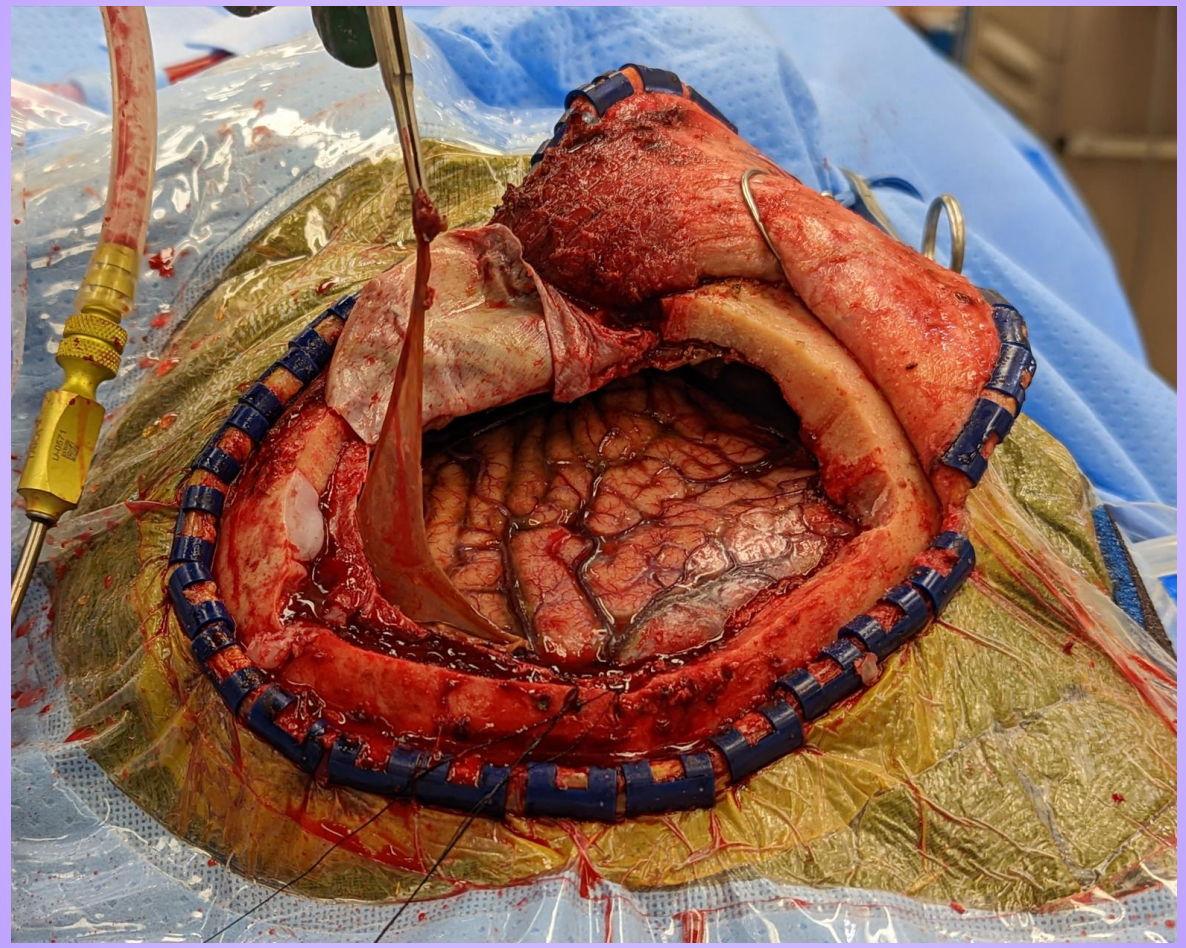

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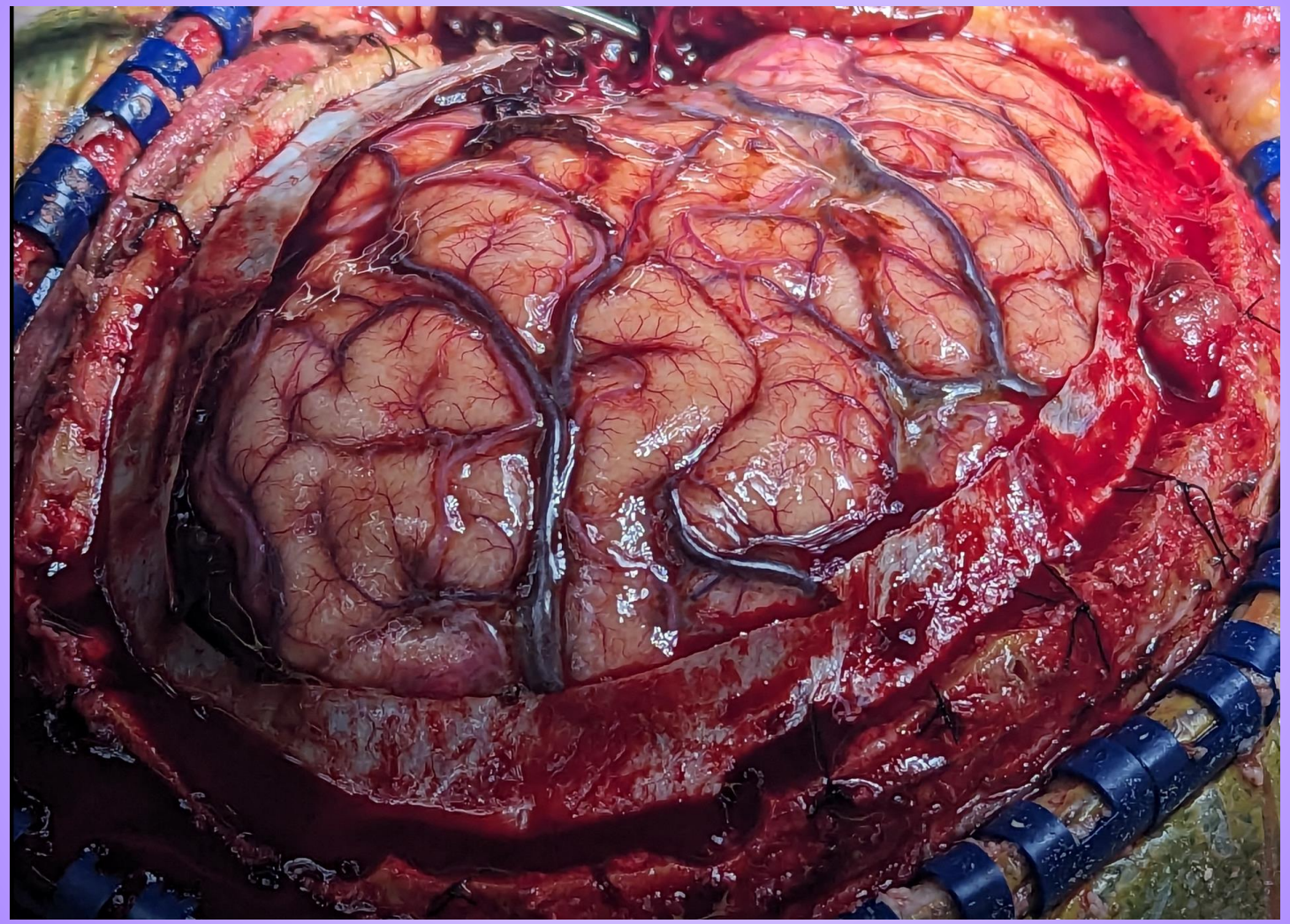

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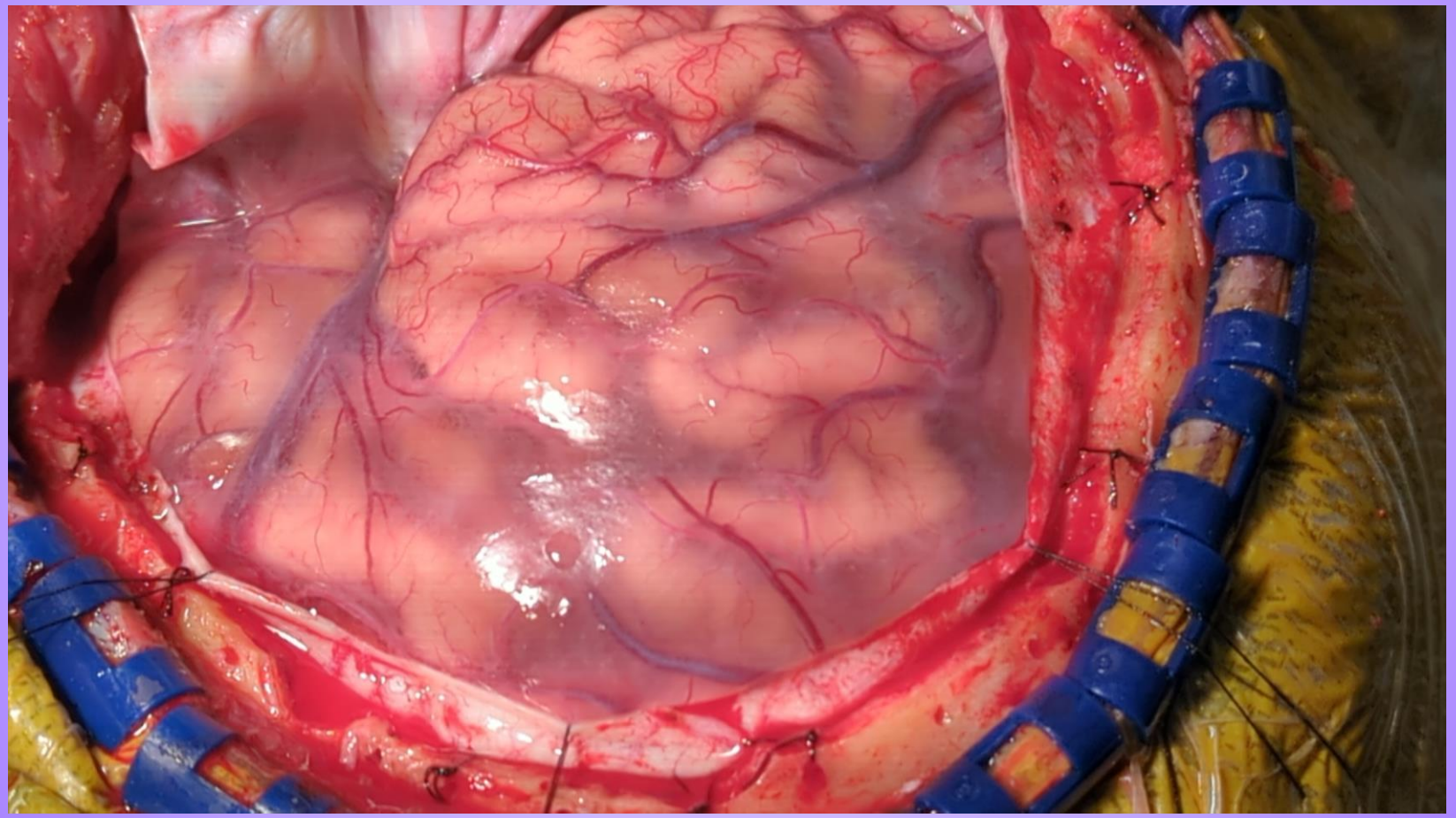

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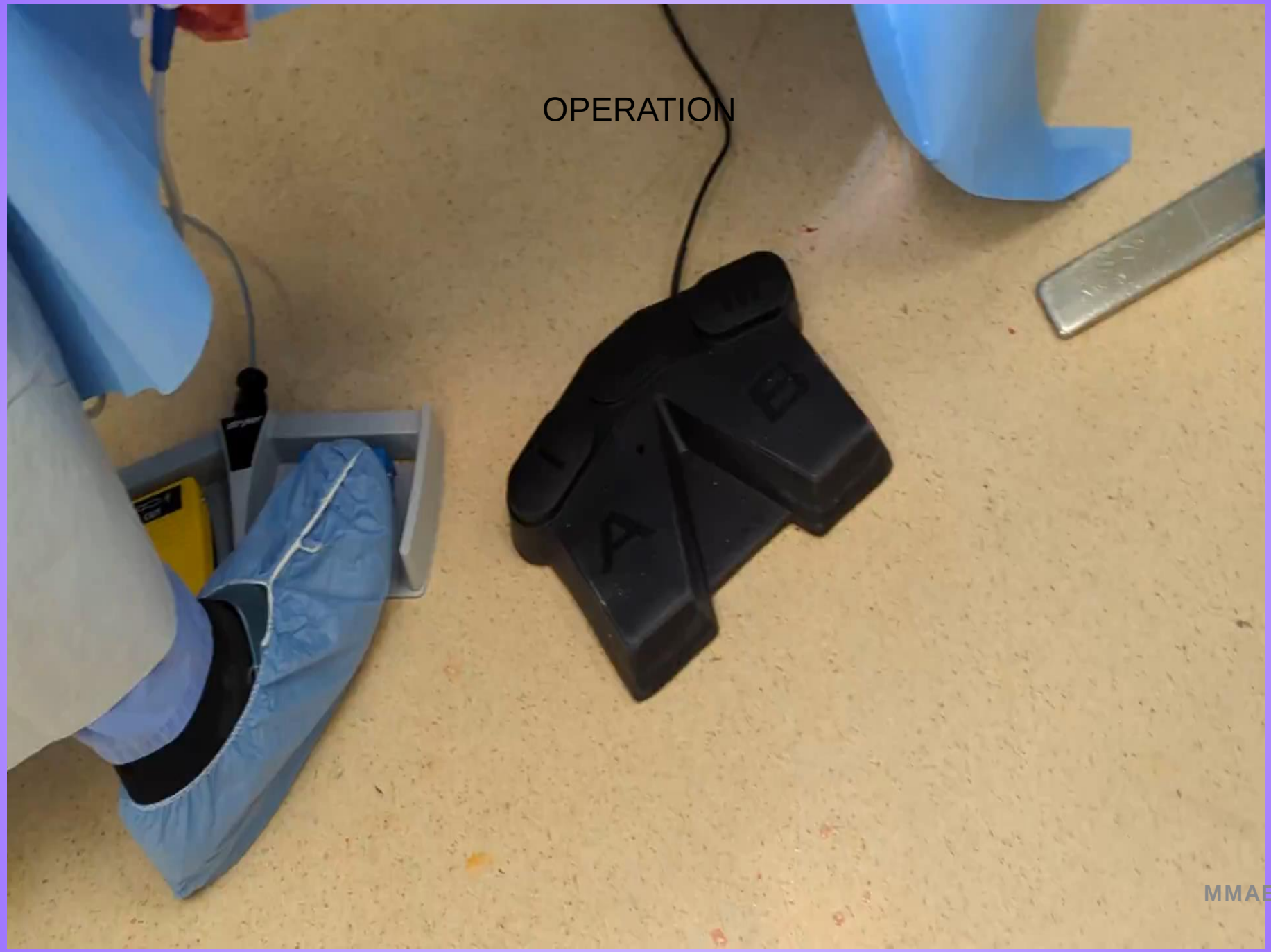

operation

BUT surgery does not address the underlying pathophysiology and may not be enough to cure the patient.

OPERATIVE RECURRENCE **0- 37%** (12.8)

Recurrent Chronic Subdural Hematoma After Burr-Hole Surgery and Postoperative Drainage: A Systematic Review and Meta-Analysis

Lodewijkx, Roger MD[*,‡]; Foppen, Merijn MD[*,‡]; Slot, Kari-Anne Mariam MD, PhD[*,‡]; Vandertop, William Peter MD, PhD[*,‡]; Verbaan, Dagmar PhD[*,‡]

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https://journals.lww.com/onsonline/fulltext/2023/09000/recurrent_chronic_subdural_hematoma_after.2.aspx 1/

Pathophysiology: inflammation, cytokine mobilization, cell proliferation, angiogenesis, bleeding

Edlmann *et al. Journal of Neuroinflammation* (2017) 14:108
DOI 10.1186/s12974-017-0881-y

Journal of Neuroinflammation

REVIEW Open Access

Pathophysiology of chronic subdural haematoma: inflammation, angiogenesis and implications for pharmacotherapy

Ellie Edlmann[1*], Susan Giorgi-Coll[1], Peter C. Whitfield[2], Keri L. H. Carpenter[1] and Peter J. Hutchinson[1]

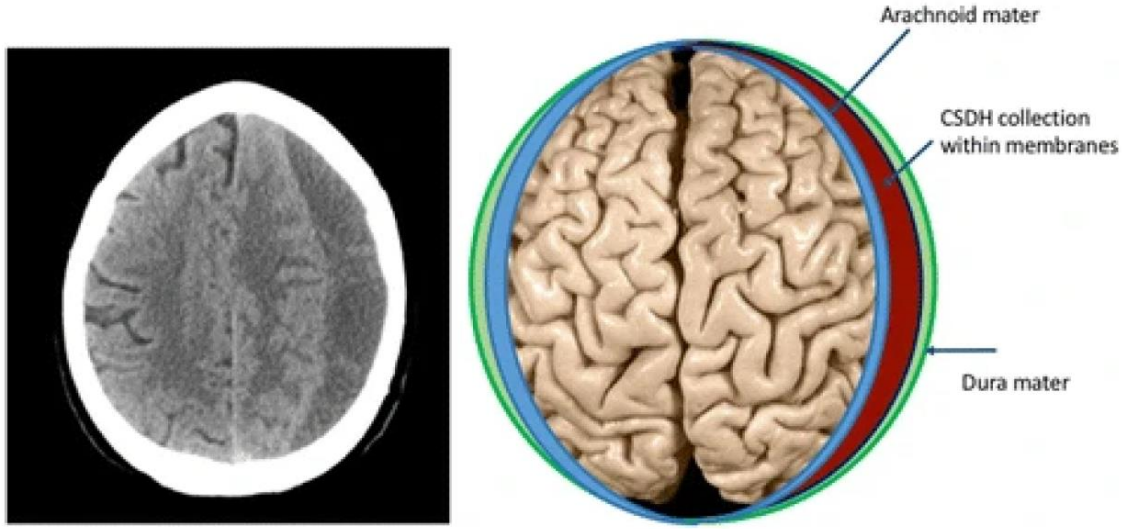
Abstract

Chronic subdural haematoma (CSDH) is an encapsulated collection of blood and fluid on the surface of the brain. Historically considered a result of head trauma, recent evidence suggests there are more complex processes involved. Trauma may be absent or very minor and does not explain the progressive, chronic course of the condition. This review focuses on several key processes involved in CSDH development: angiogenesis, fibrinolysis and inflammation. The characteristic membrane surrounding the CSDH has been identified as a source of fluid exudation and haemorrhage. Angiogenic stimuli lead to the creation of fragile blood vessels within membrane walls, whilst fibrinolytic processes prevent clot formation resulting in continued haemorrhage. An abundance of inflammatory cells and markers have been identified within the membranes and subdural fluid and are likely to contribute to propagating an inflammatory response which stimulates ongoing membrane growth and fluid accumulation. Currently, the mainstay of treatment for CSDH is surgical drainage, which has associated risks of recurrence requiring repeat surgery. Understanding of the underlying pathophysiological processes has been applied to developing potential drug

CSDH

Fig. 1

From: Pathophysiology of chronic subdural haematoma: inflammation, angiogenesis and implications for pharmacotherapy

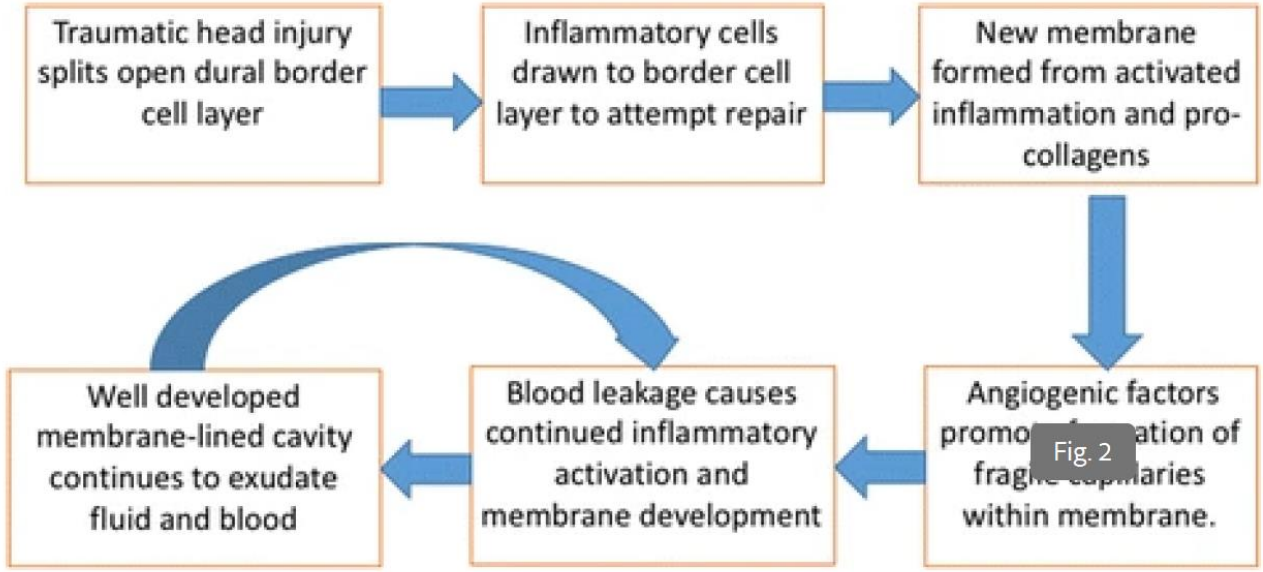


Computed tomography (CT) head scan and schematic representation of a CSDH

Pathophysiology

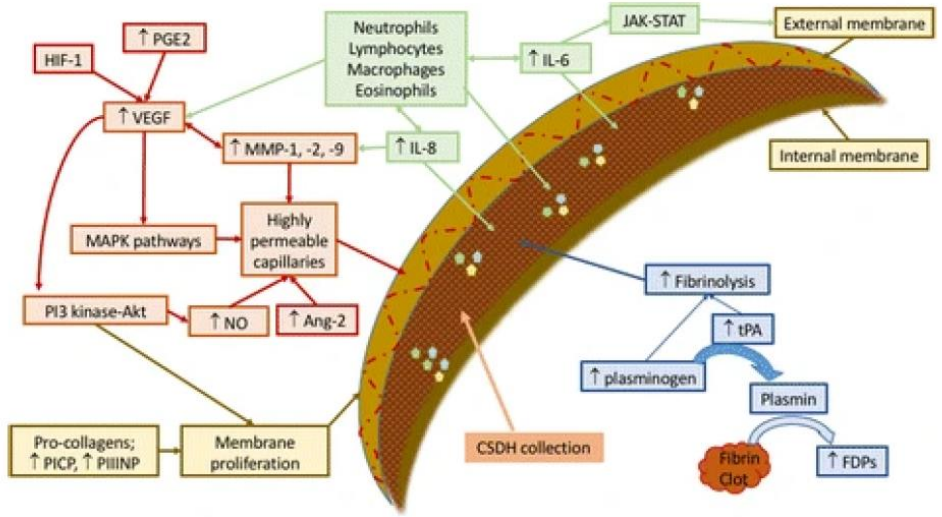
Fig. 2

From: Pathophysiology of chronic subdural haematoma: inflammation, angiogenesis and implications for pharmacotherapy



The CSDH cycle. Summary of the pathophysiological processes involved in the formation of a CSDH

From: Pathophysiology of chronic subdural haematoma: inflammation, angiogenesis and implications for pharmacotherapy



Summary of molecules associated with CSDH formation including recruitment of inflammatory cells (*green*), angiogenesis of highly permeable and leaky capillaries (*red*), processes supporting membrane formation (*brown*) and fibrinolysis promoting further haemorrhage (*blue*). *Abbreviations: Ang* angiopoietin, *FDPs* fibrin/fibrinogen degradation products, *HIF* hypoxia-inducible factor, *IL* interleukin, *JAK-STAT* Janus kinase-signal transducer and activator of transcription, *MAPK* mitogen-activated protein kinase, *MMP* matrix metalloproteinase, *NO* nitric oxide, *PGE* prostaglandin E, *PI3-Akt* phosphatidylinositol 3-kinase-serine/threonine kinase, *PICP* procollagen type 1, *PIIINP*

No Shinkei Geka legacy: Sato and Suzuki, 1975

Ultrastructural observations of the capsule of chronic subdural hematoma in various clinical stages

So Sato, M.D., and Jiro Suzuki, M.D.

Division of Neurosurgery, Institute of Brain Diseases, Tohoku University School of Medicine, Sendai, Japan

The authors used light and electron microscope to examine the capsules of chronic subdural hematoma in 33 cases. In cases with neurological deficits, capillary endothelial cells in the capsule had many cytoplasmic protrusions and fenestrations, suggesting high permeability of the capillary wall. Endothelial degeneration was also observed in these cases. These morphological changes were reversed by osmotherapy. Formation of collagen fibrils from fibroblasts in the hematoma capsule was frequently observed in the cases treated by osmotherapy.

Key Words • **subdural hematoma** • **head injury** • **osmotherapy** • **capillary** • **collagen formation** • **ultrastructure**

Since the detailed description of pachymeningitis hemorrhagica interna was reported by Virchow,[21] many theories of the etiology or pathogenesis of chronic subdural hematoma have been

are reporting our study of the morphological changes in the hematoma capsule in various stages of treatment with osmotherapy. Our findings are compared with those in untreated cases. Using these data we discuss the

No Shinkei Geka legacy: Sato and Suzuki: the membrane's thin endothelium

S. Sato and J. Suzuki

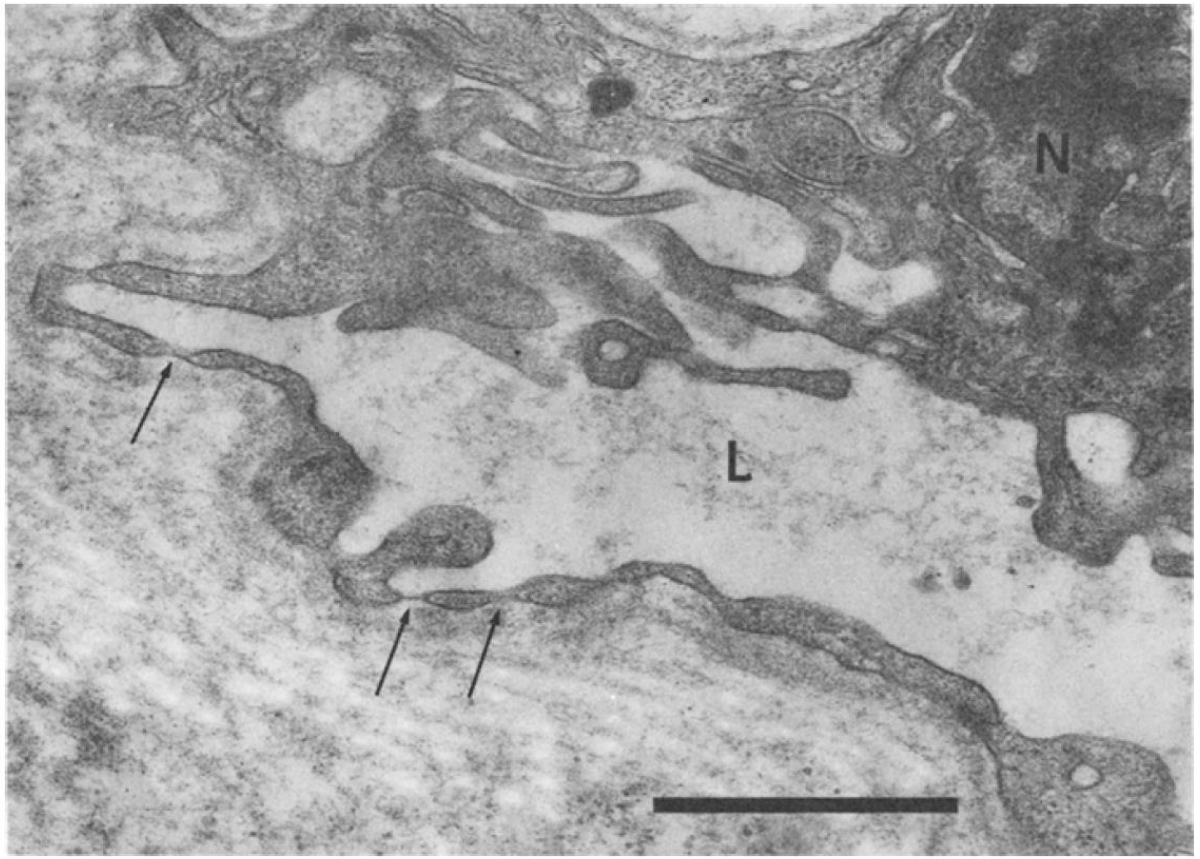


FIG. 3. Electron micrograph showing endothelial fenestrations *(arrows)*, found among the thin endothelial cytoplasm. L = lumen of the capillary; N = nucleus of the endothelial cell. Calibration, 1 μ.

Sato and Suzuki, 1975: Leaky capillaries of the CSDH membrane

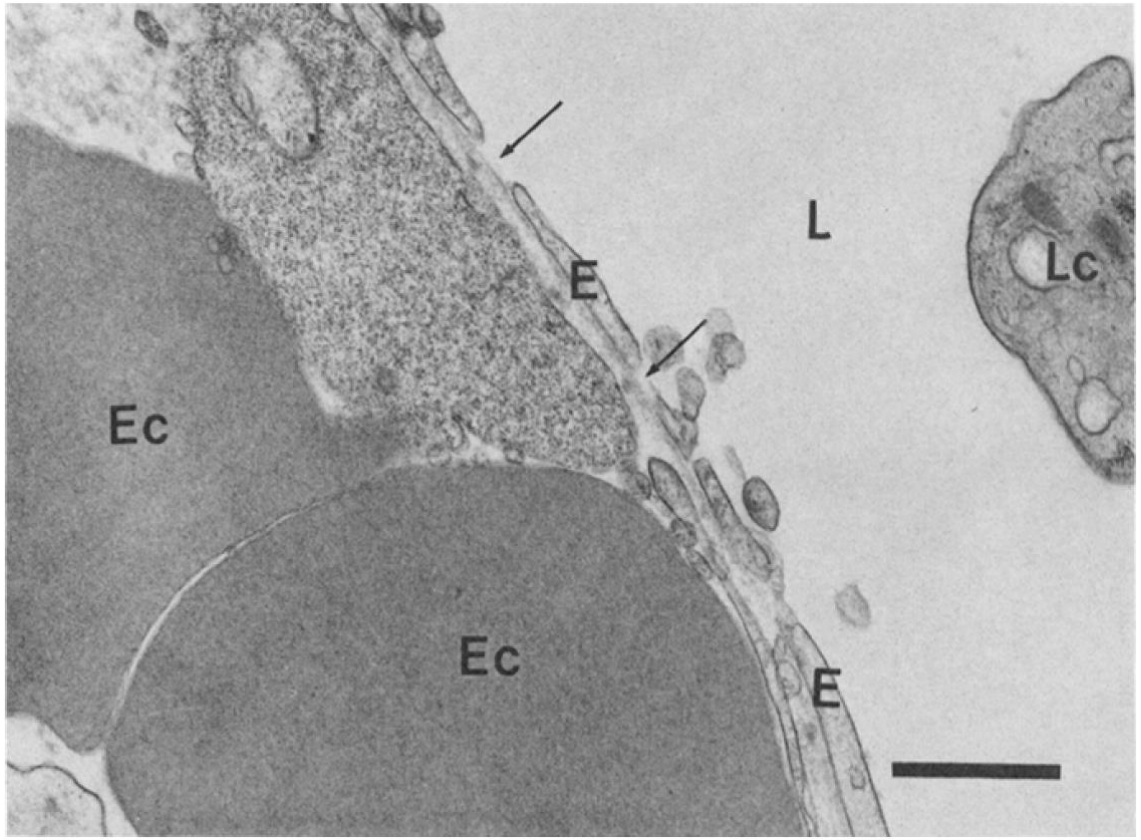
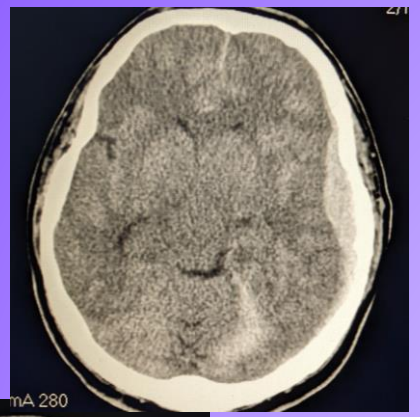
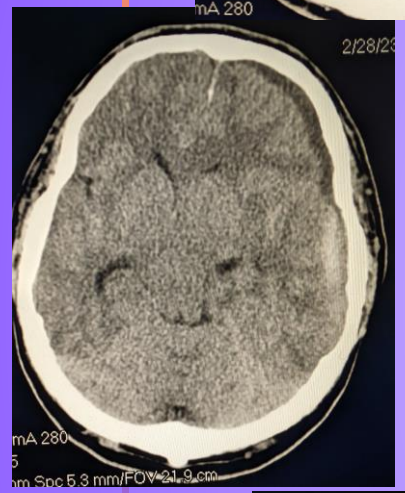
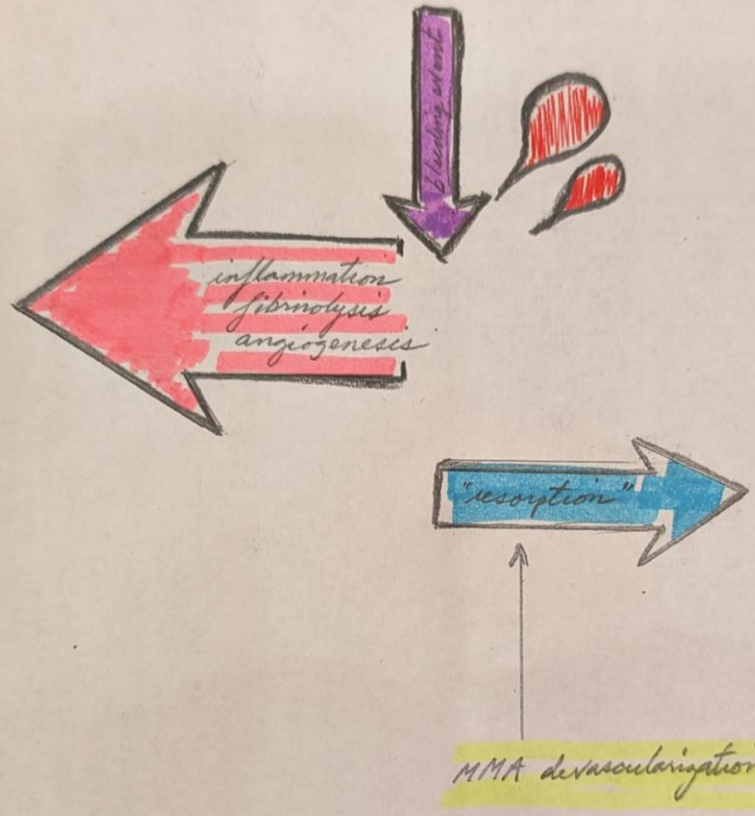


FIG. 4. Electron micrograph of a portion of a capillary. Endothelial cells (E) are very thin and open gaps *(arrows)* are found among them. There are two erythrocytes (Ec) at the outside of the capillary wall and a part of a leucocyte (Lc) in the lumen (L). Calibration, 1 μ.

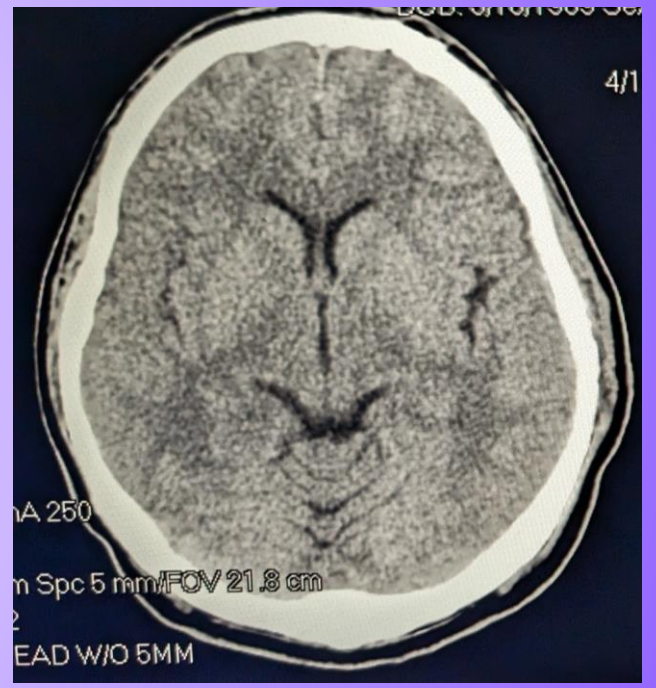




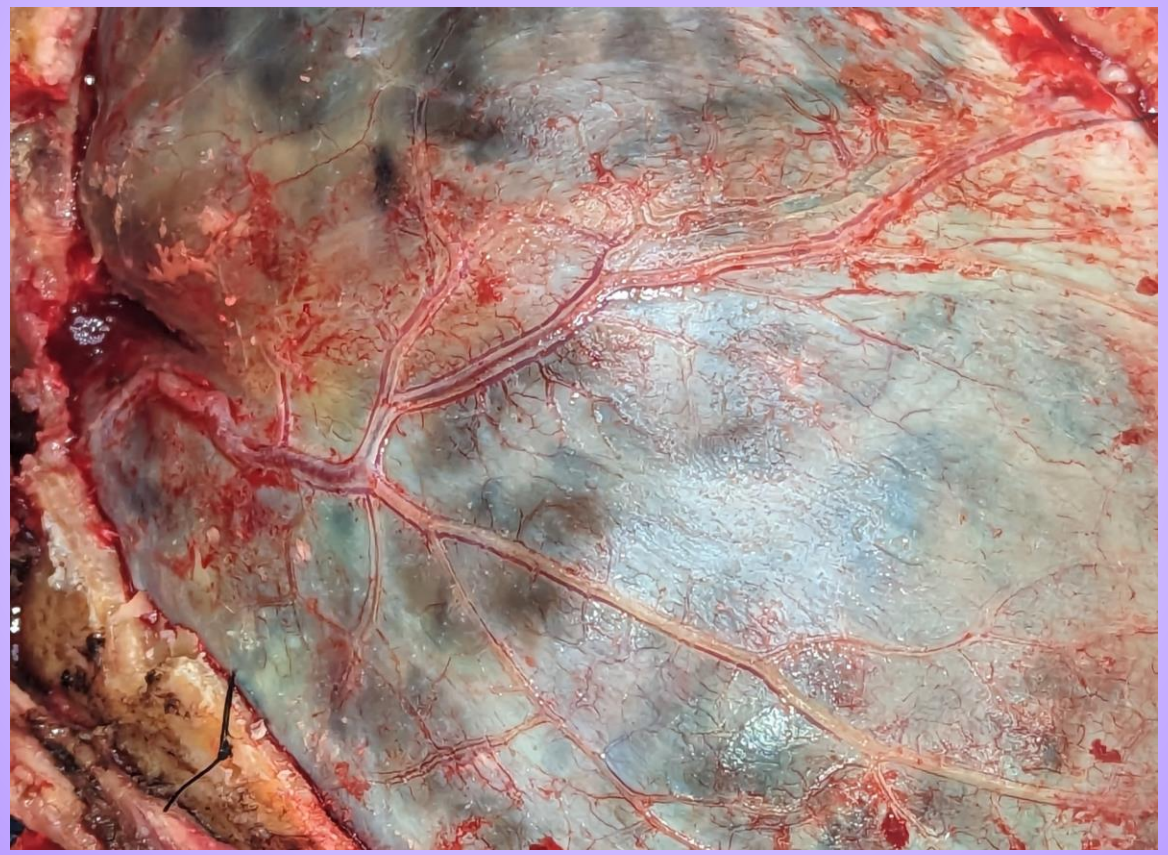
CSDH Equilibrium: Role of MMAE



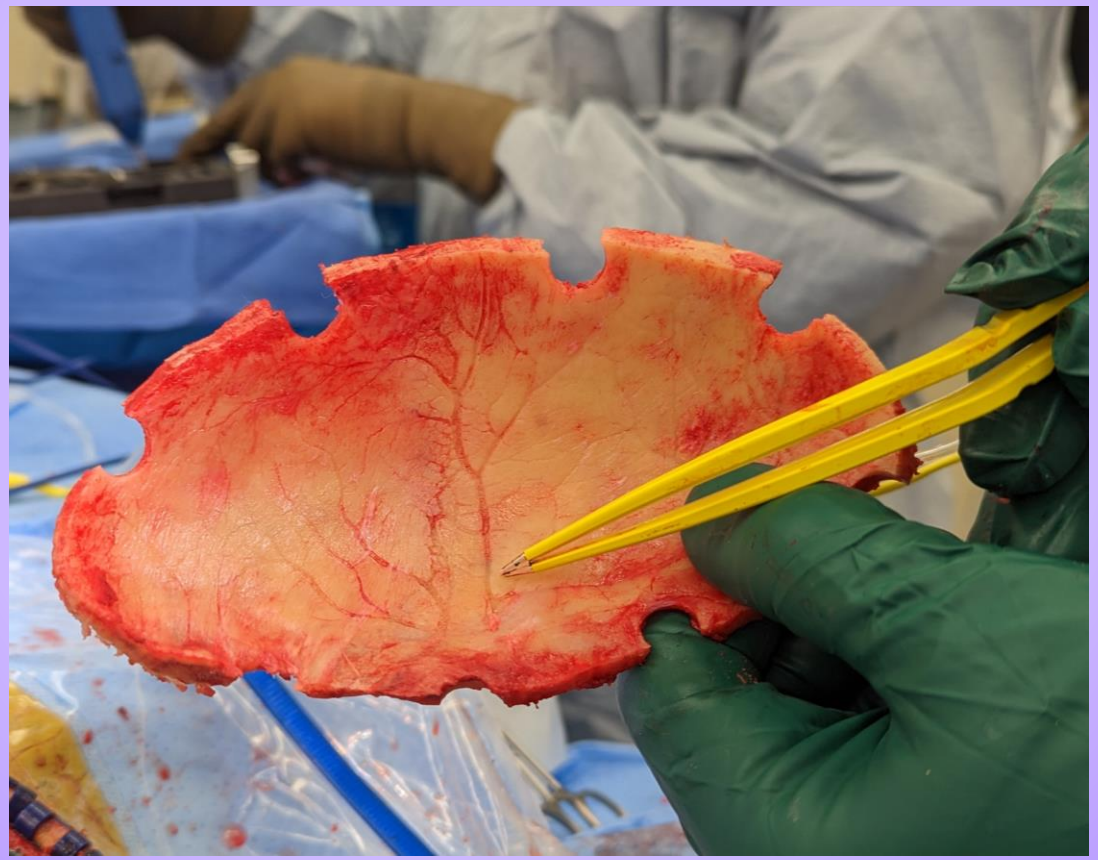
Model of dynamic pathophysiology of chronic subdural hematoma.



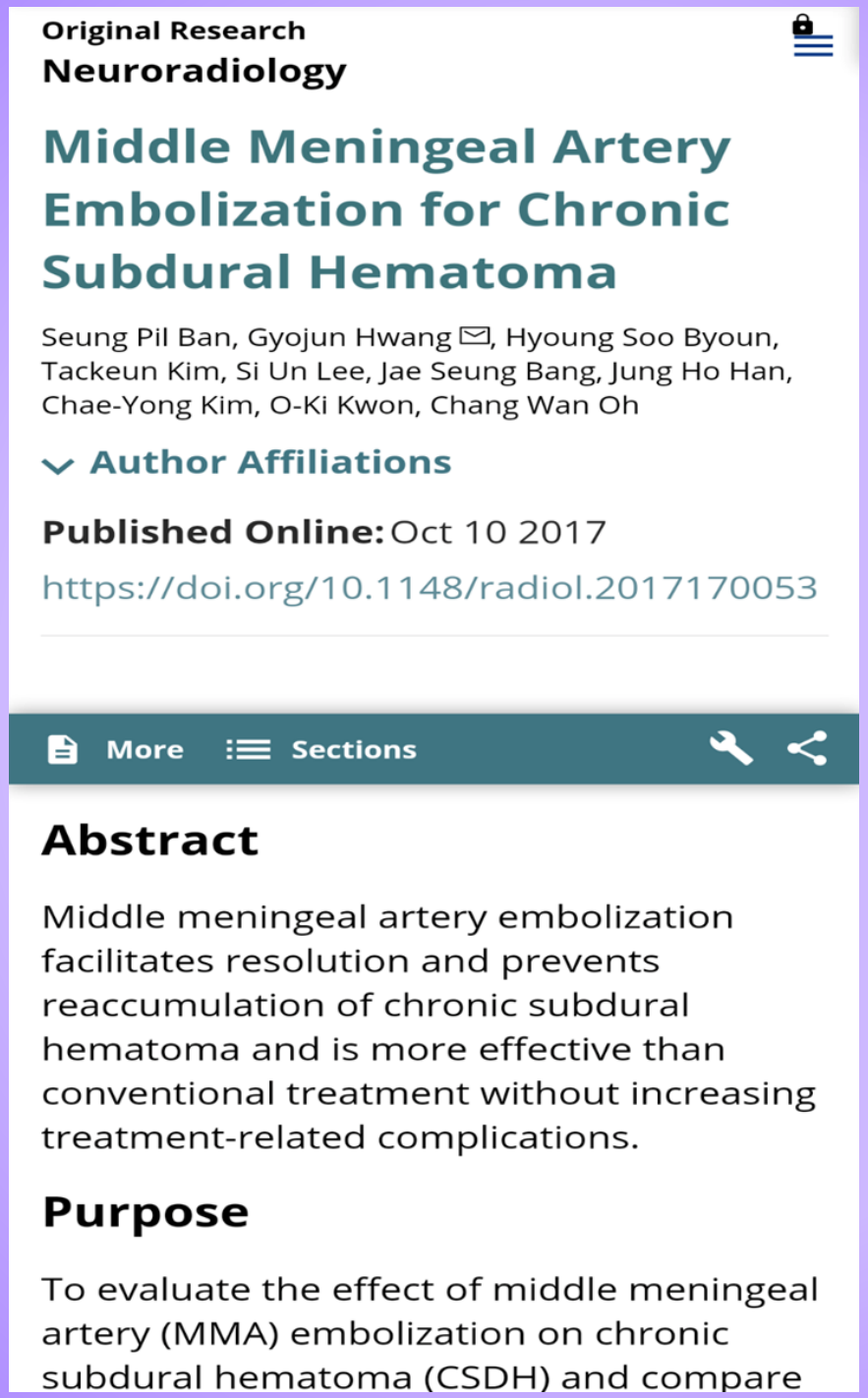
Middle meningeal artery (MMA): the source of pathological neovascularization of the CSDH membrane



TARGET = MMA



MMA: “talk and die” syndrome



Original Research
Neuroradiology

Middle Meningeal Artery Embolization for Chronic Subdural Hematoma

Seung Pil Ban, Gyojun Hwang ✉, Hyoung Soo Byoun, Tackeun Kim, Si Un Lee, Jae Seung Bang, Jung Ho Han, Chae-Yong Kim, O-Ki Kwon, Chang Wan Oh

Author Affiliations

Published Online: Oct 10 2017

https://doi.org/10.1148/radiol.2017170053

More Sections

Abstract

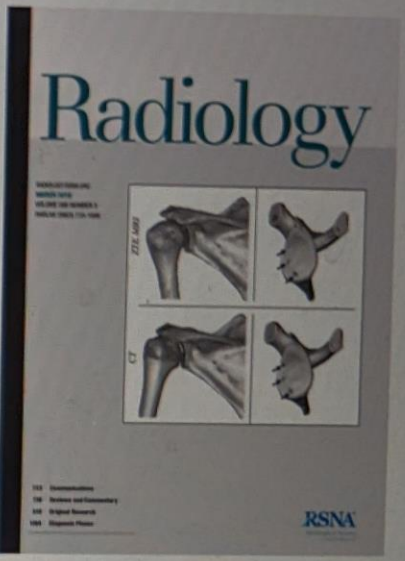
Middle meningeal artery embolization facilitates resolution and prevents reaccumulation of chronic subdural hematoma and is more effective than conventional treatment without increasing treatment-related complications.

Purpose

To evaluate the effect of middle meningeal artery (MMA) embolization on chronic subdural hematoma (CSDH) and compare

Radiology, Vol 286 No. 3

excluded. Seventy-two prospectively enrolled patients with CSDH underwent MMA embolization (embolization group; as the sole treatment in 27 [37.5%] asymptomatic patients and with additional hematoma removal for symptom relief in 45 [62.5%] symptomatic patients). For comparison, 469 patients who underwent conventional treatment were included as a historical control group (conventional treatment group; close, nonsurgical follow-up in 67 [14.3%] and hematoma removal in 402 [85.7%] patients). Primary outcome was treatment failure defined as a composite of incomplete hematoma resolution (remaining or reaccumulated hematoma with thickness > 10 mm) or surgical rescue (hematoma removal for relief of symptoms that developed with continuous growth of initial or reaccumulated hematoma). Secondary outcomes included surgical rescue as a component of the primary outcome and treatment-related complication for safety measure. Six-month outcomes were compared between the study groups with logistic regression analysis.



Vol. 286, No. 3

Results

Spontaneous hematoma resolution was achieved in all of 27 asymptomatic patients undergoing embolization without direct hematoma removal. Hematoma reaccumulation occurred in one (2.2%) of 45 symptomatic patients receiving embolization with additional hematoma removal. Treatment failure rate in the embolization group was lower than in the conventional treatment group (one of 72 patients [1.4%] vs 129 of 469 patients [27.5%], respectively; adjusted odds ratio [OR], 0.056; 95% confidence interval [CI]: 0.011, 0.286; P = .001). Surgical rescue was less frequent in the embolization group (one of 72 patients [1.4%] vs 88 of 469 patients [18.8%]; adjusted OR, 0.094; 95% CI: 0.018, 0.488; P = .005). Treatment-related complication rate was not different between the two groups (0 of 72 patients vs 20 of

Mandai et al., 2000

S Mandai [1], M Sakurai, Y Matsumoto

Affiliations + expand

PMID: 11014549 DOI: 10.3171/jns.2000.93.4.0686

Abstract

The authors present a case of refractory chronic subdural hematoma (CSH) in a 59-year-old man with coagulopathy due to liver cirrhosis. The patient was successfully treated by embolization of the middle meningeal artery after several drainage procedures. This new therapeutic approach to recurrent CSH is discussed.

Case Reports No Shinkei Geka. 1998 Apr;26(4):339-47.

[Superselective angiographic findings of ipsilateral middle meningeal artery of chronic subdural hematoma in adults]

[Article in Japanese]

T Tanaka [1], S Fujimoto, K Saitoh, S Satoh, K Nagamatsu, H Midorikawa

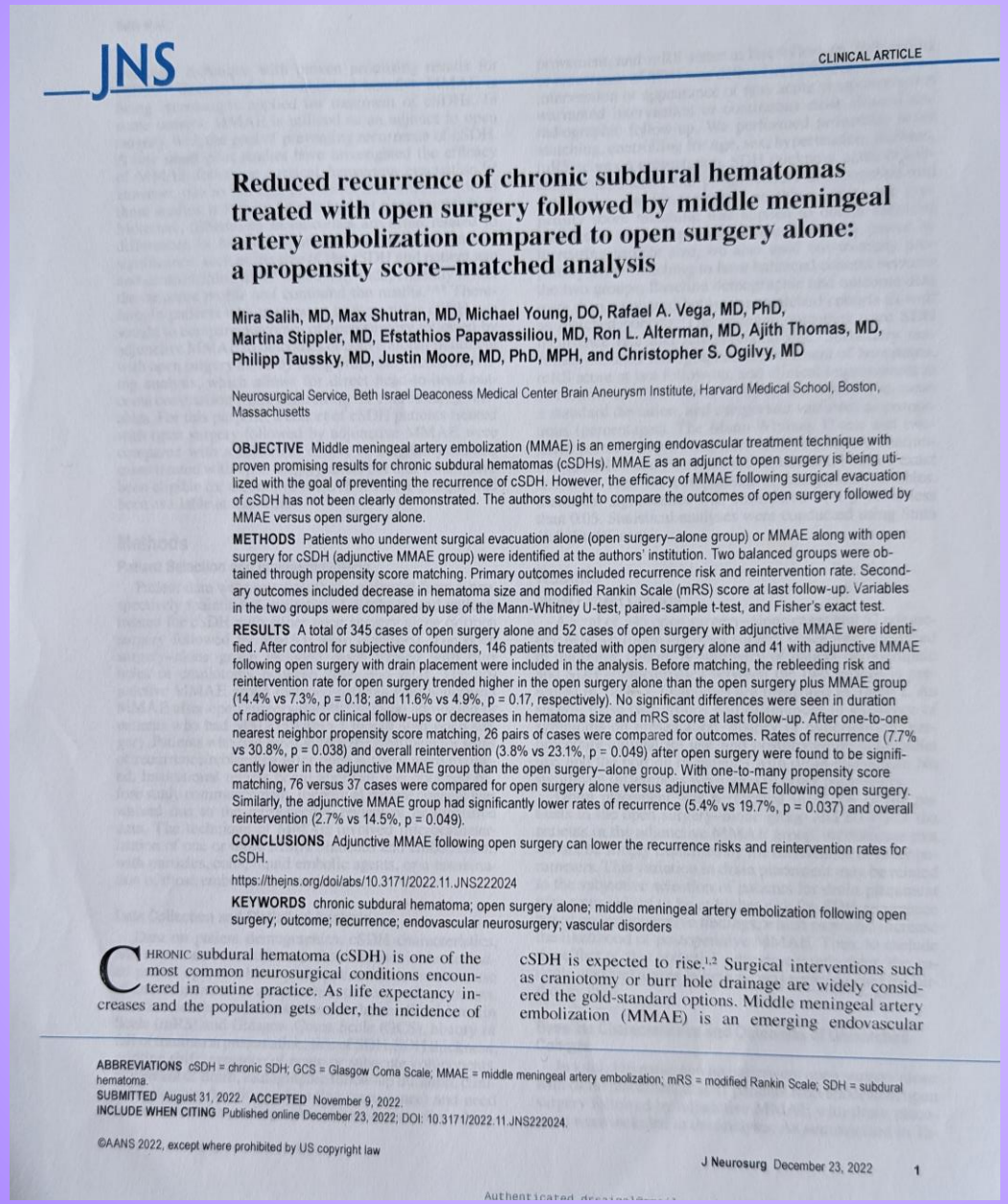
Affiliations

PMID: 9592815

Abstract

The authors reported the results of continuous superselective angiography of the ipsilateral middle meningeal artery (MMA) in cases of chronic subdural hematoma (CSH) in adults. MMA angiography was performed twice, at an interval of approximately two weeks, in 3 cases of conservative and 1 case of surgical treatment. The features of MMA angiographic findings were diffuse dilatation of MMA and visualization of scattered abnormal vascular networks (VN), which seemed to be macrocapillaries in the outer membrane of the CSH. In two out of the three cases of conservative treatment, these VN revealed a dynamic change temporarily and spatially, i.e. either enlargement or reduction. In one case with a long clinical course a stable MMA angiogram was seen. The operated case showed dramatic change on the second (postoperative) MMA angiogram. The VN around burr hole portion was huge and dark, and several newly visualized small arteries penetrated the enlarged VN, which was thought to have been caused by the operation. The mean blood pressure in the MMA was 103 mmHg. The reason for the acute enlargement of the CSH might be explained as arterial bleeding into the hematoma cavity, caused by rupture of thin walled macrocapillaries by direct arterial pressure

Interest prompted in both adjunctive and preemptive MMAE



JNS

CLINICAL ARTICLE

Reduced recurrence of chronic subdural hematomas treated with open surgery followed by middle meningeal artery embolization compared to open surgery alone: a propensity score–matched analysis

Mira Salih, MD, Max Shutran, MD, Michael Young, DO, Rafael A. Vega, MD, PhD, Martina Stippler, MD, Efstathios Papavassiliou, MD, Ron L. Alterman, MD, Ajith Thomas, MD, Philipp Taussky, MD, Justin Moore, MD, PhD, MPH, and Christopher S. Ogilvy, MD

Neurosurgical Service, Beth Israel Deaconess Medical Center Brain Aneurysm Institute, Harvard Medical School, Boston, Massachusetts

OBJECTIVE Middle meningeal artery embolization (MMAE) is an emerging endovascular treatment technique with proven promising results for chronic subdural hematomas (cSDHs). MMAE as an adjunct to open surgery is being utilized with the goal of preventing the recurrence of cSDH. However, the efficacy of MMAE following surgical evacuation of cSDH has not been clearly demonstrated. The authors sought to compare the outcomes of open surgery followed by MMAE versus open surgery alone.

METHODS Patients who underwent surgical evacuation alone (open surgery–alone group) or MMAE along with open surgery for cSDH (adjunctive MMAE group) were identified at the authors' institution. Two balanced groups were obtained through propensity score matching. Primary outcomes included recurrence risk and reintervention rate. Secondary outcomes included decrease in hematoma size and modified Rankin Scale (mRS) score at last follow-up. Variables in the two groups were compared by use of the Mann-Whitney U-test, paired-sample t-test, and Fisher's exact test.

RESULTS A total of 345 cases of open surgery alone and 52 cases of open surgery with adjunctive MMAE were identified. After control for subjective confounders, 146 patients treated with open surgery alone and 41 with adjunctive MMAE following open surgery with drain placement were included in the analysis. Before matching, the rebleeding risk and reintervention rate for open surgery trended higher in the open surgery alone than the open surgery plus MMAE group (14.4% vs 7.3%, p = 0.18; and 11.6% vs 4.9%, p = 0.17, respectively). No significant differences were seen in duration of radiographic or clinical follow-ups or decreases in hematoma size and mRS score at last follow-up. After one-to-one nearest neighbor propensity score matching, 26 pairs of cases were compared for outcomes. Rates of recurrence (7.7% vs 30.8%, p = 0.038) and overall reintervention (3.8% vs 23.1%, p = 0.049) after open surgery were found to be significantly lower in the adjunctive MMAE group than the open surgery–alone group. With one-to-many propensity score matching, 76 versus 37 cases were compared for open surgery alone versus adjunctive MMAE following open surgery. Similarly, the adjunctive MMAE group had significantly lower rates of recurrence (5.4% vs 19.7%, p = 0.037) and overall reintervention (2.7% vs 14.5%, p = 0.049).

CONCLUSIONS Adjunctive MMAE following open surgery can lower the recurrence risks and reintervention rates for cSDH.

https://thejns.org/doi/abs/10.3171/2022.11.JNS222024

KEYWORDS chronic subdural hematoma; open surgery alone; middle meningeal artery embolization following open surgery; outcome; recurrence; endovascular neurosurgery; vascular disorders

CHRONIC subdural hematoma (cSDH) is one of the most common neurosurgical conditions encountered in routine practice. As life expectancy increases and the population gets older, the incidence of cSDH is expected to rise.[1,2] Surgical interventions such as craniotomy or burr hole drainage are widely considered the gold-standard options. Middle meningeal artery embolization (MMAE) is an emerging endovascular

ABBREVIATIONS cSDH = chronic SDH; GCS = Glasgow Coma Scale; MMAE = middle meningeal artery embolization; mRS = modified Rankin Scale; SDH = subdural hematoma.

SUBMITTED August 31, 2022. **ACCEPTED** November 9, 2022.
INCLUDE WHEN CITING Published online December 23, 2022; DOI: 10.3171/2022.11.JNS222024.

Technique

GETA

Microcatheter (Excelsior SL-10)

External carotid angiography (5F Berenstein)

Subtraction technique for superselective MMA

Microangiography

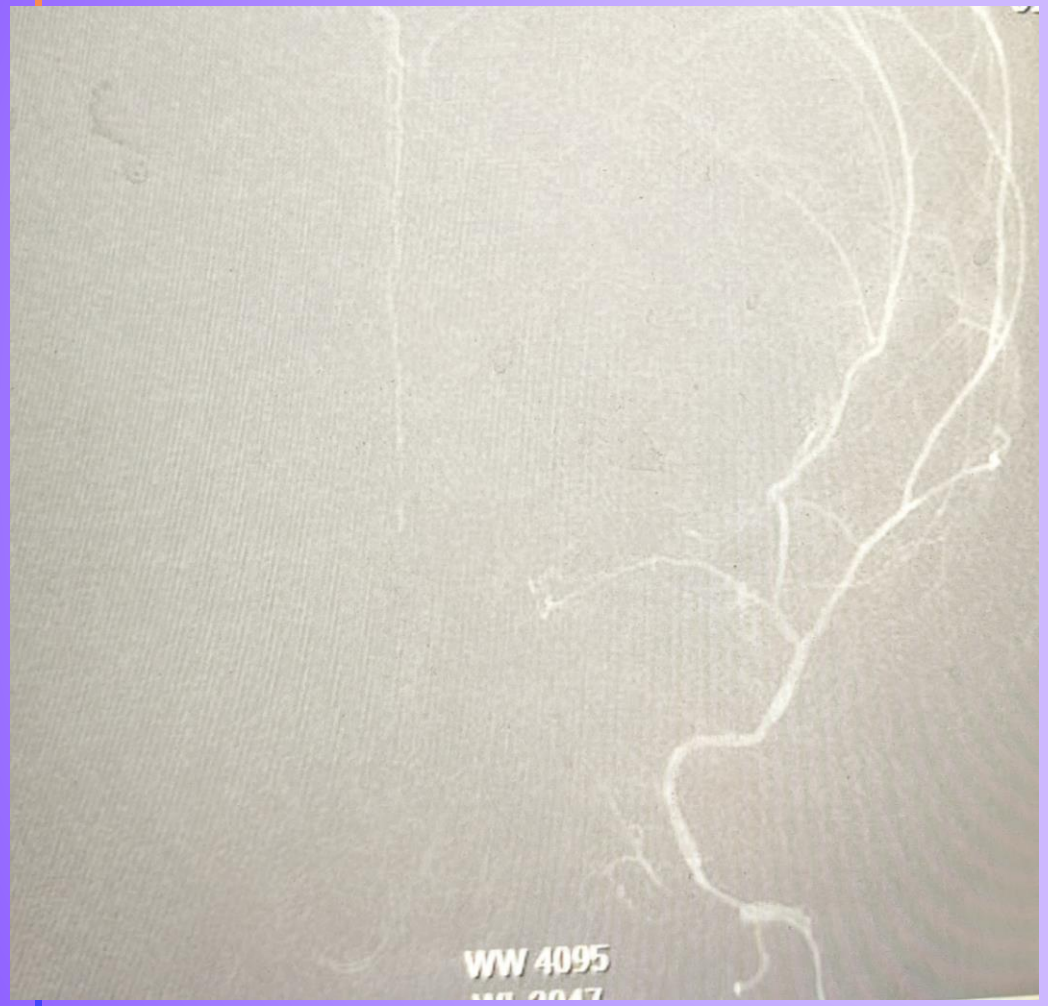
PVA 45-150 micron in 50% contrast slurry

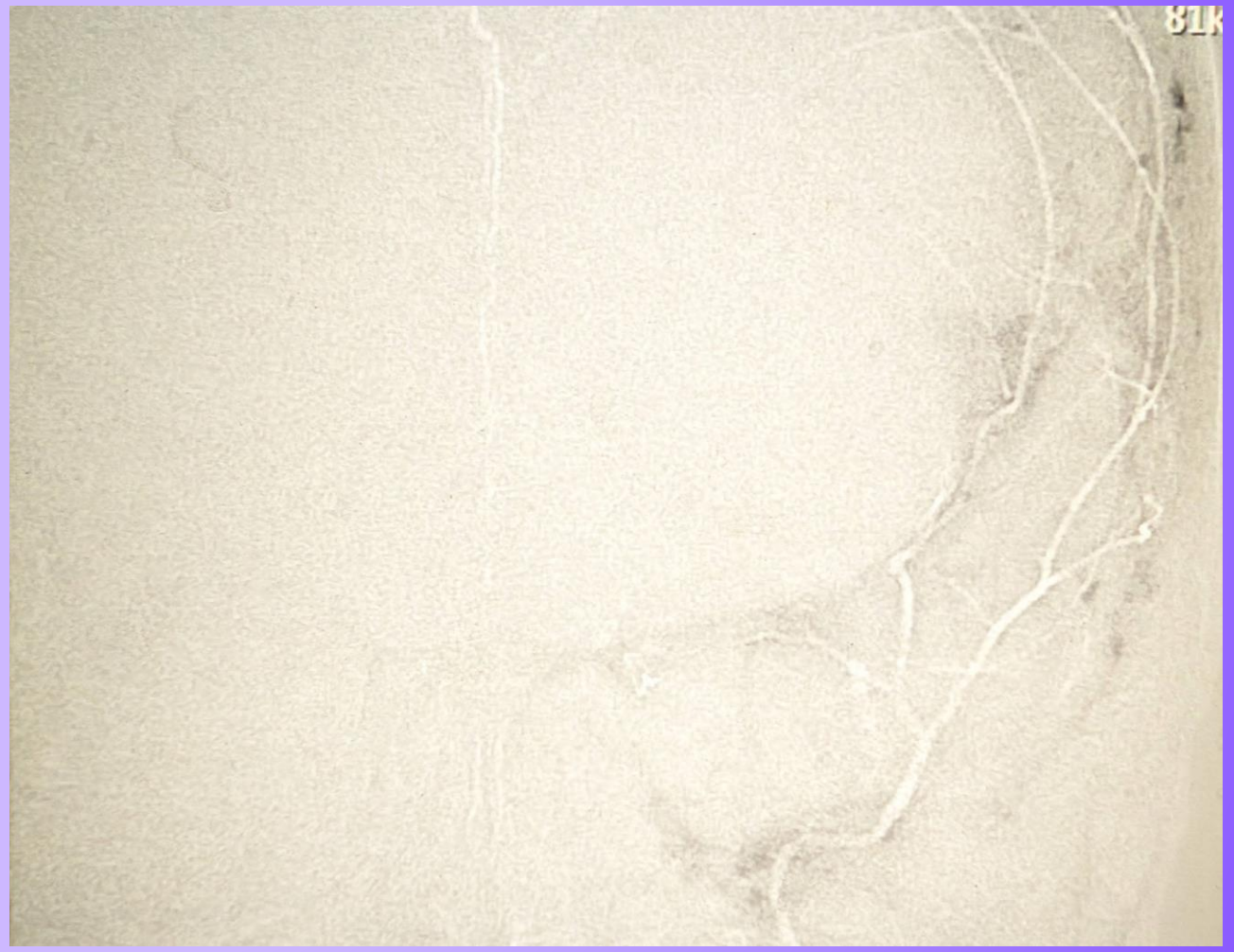
Blank subtraction for optimal visualization

Pulsed injection technique matching audible systole on EKG

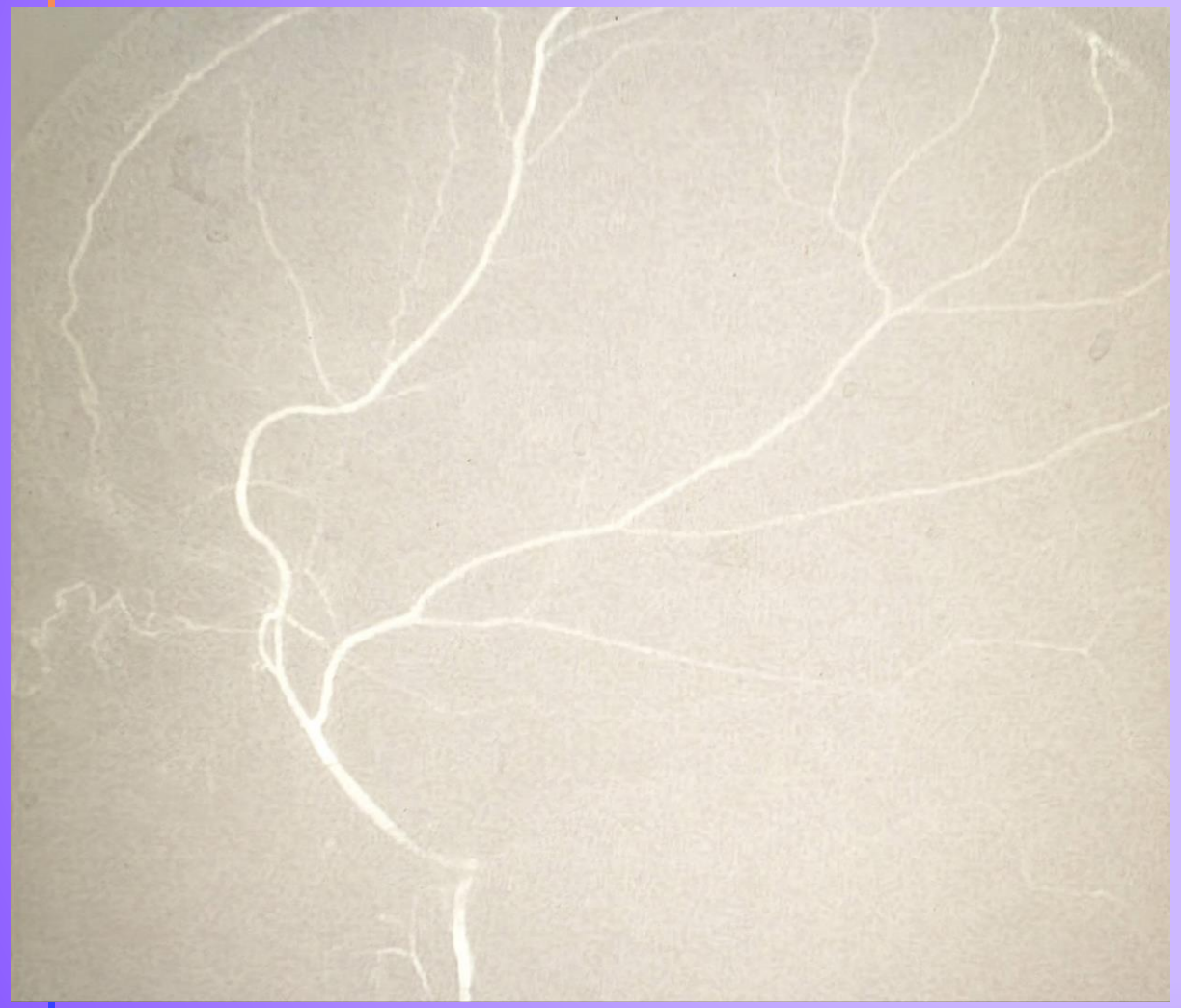
Observe blush development and reflux, dangerous anastomoses

12/02/2019 Superselective subtraction demonstrates membrane blush

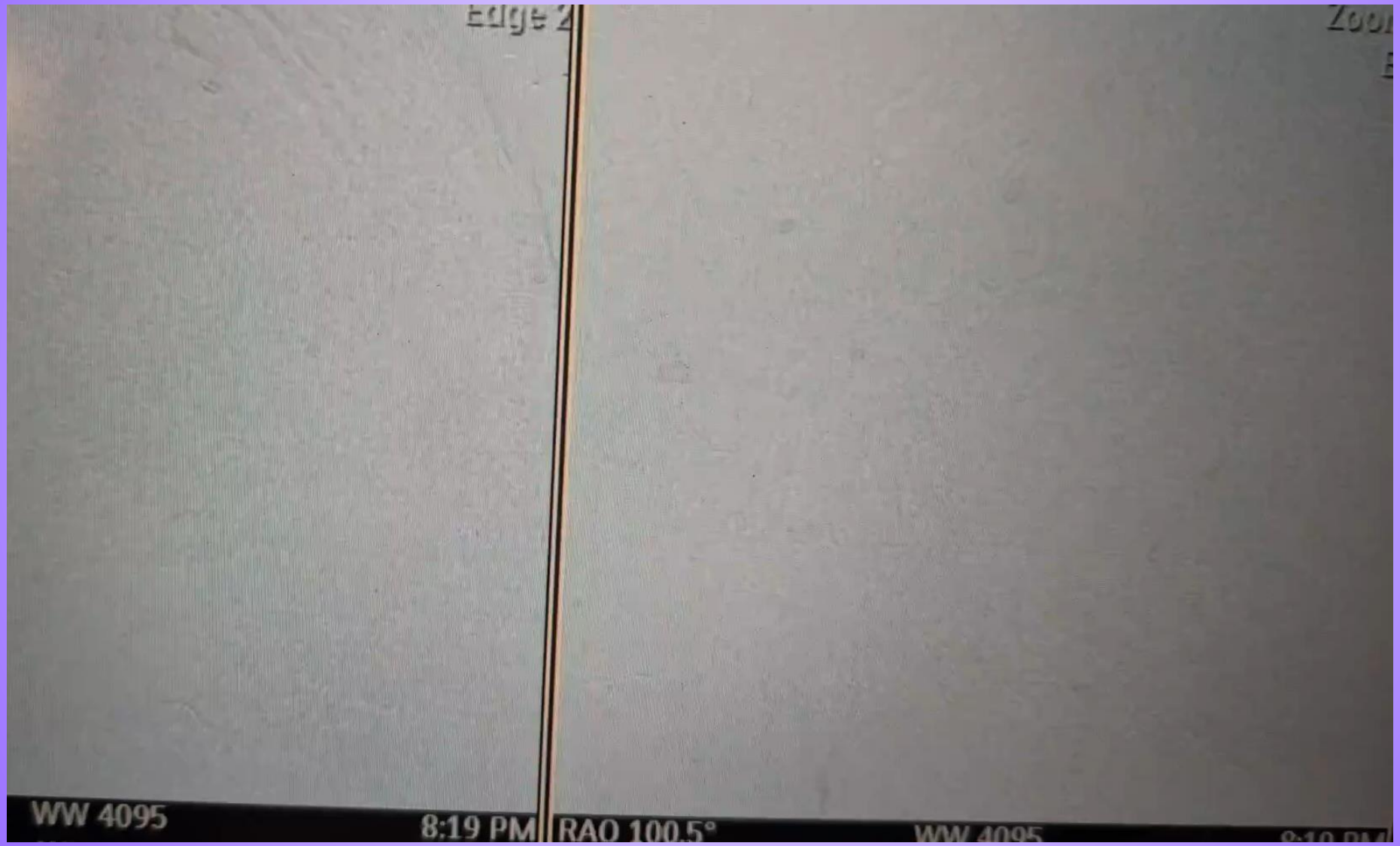




Superselective subtraction demonstrates membrane blush

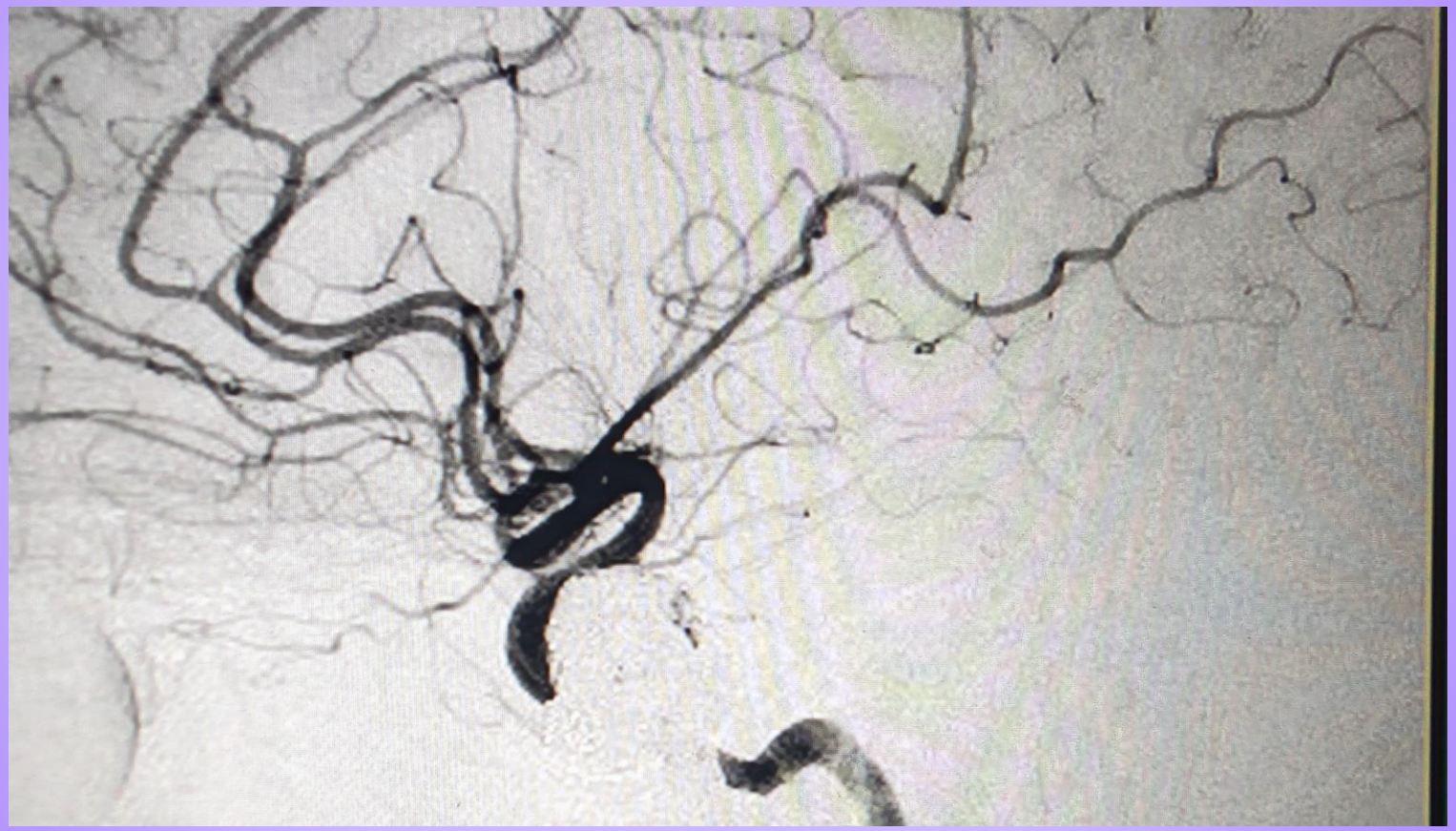


membrane blush



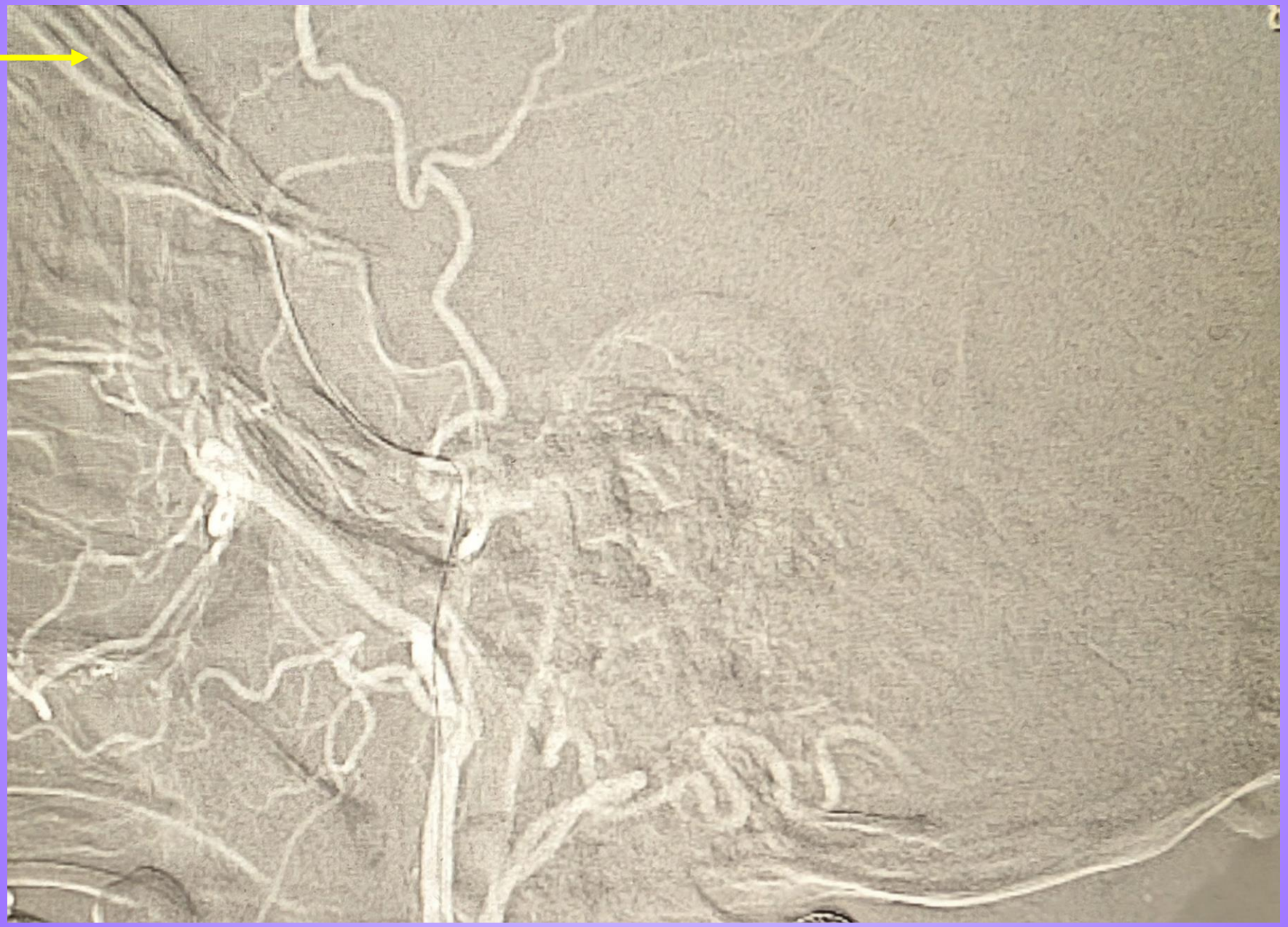
MMA embolized

Retinal blush

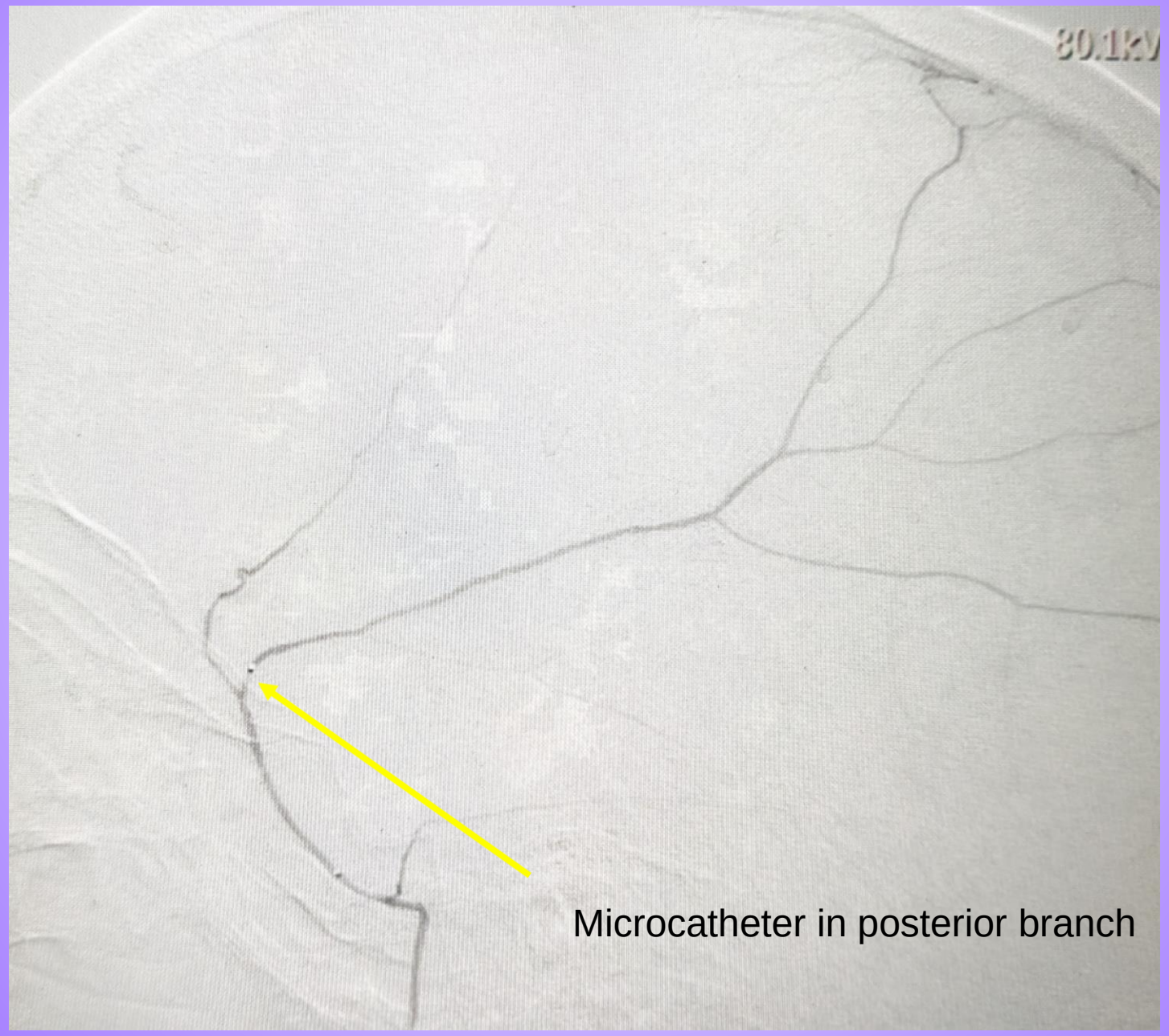


1. Ideal blush in MMAE: predictive ?

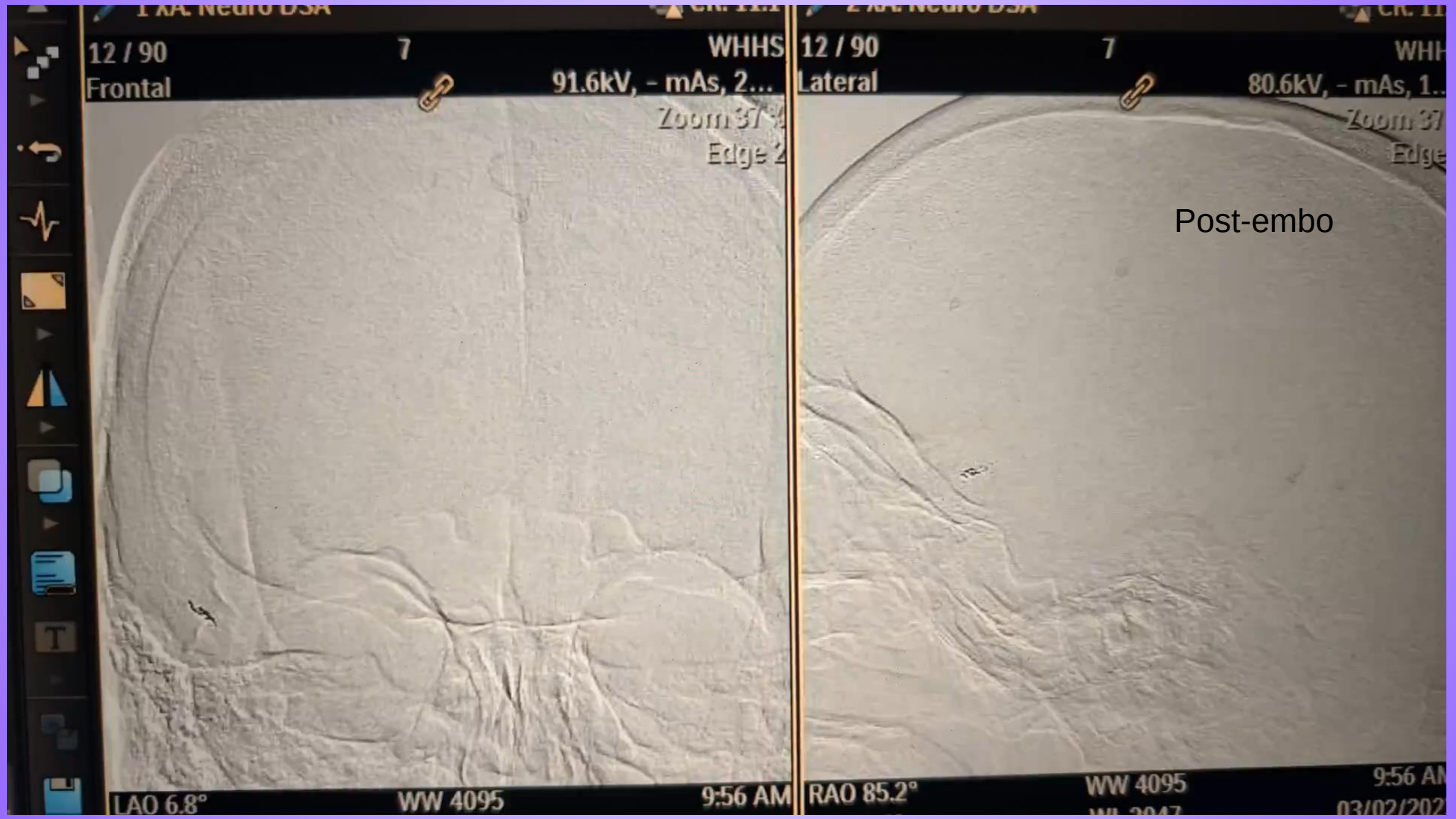
2. Superselective navigation



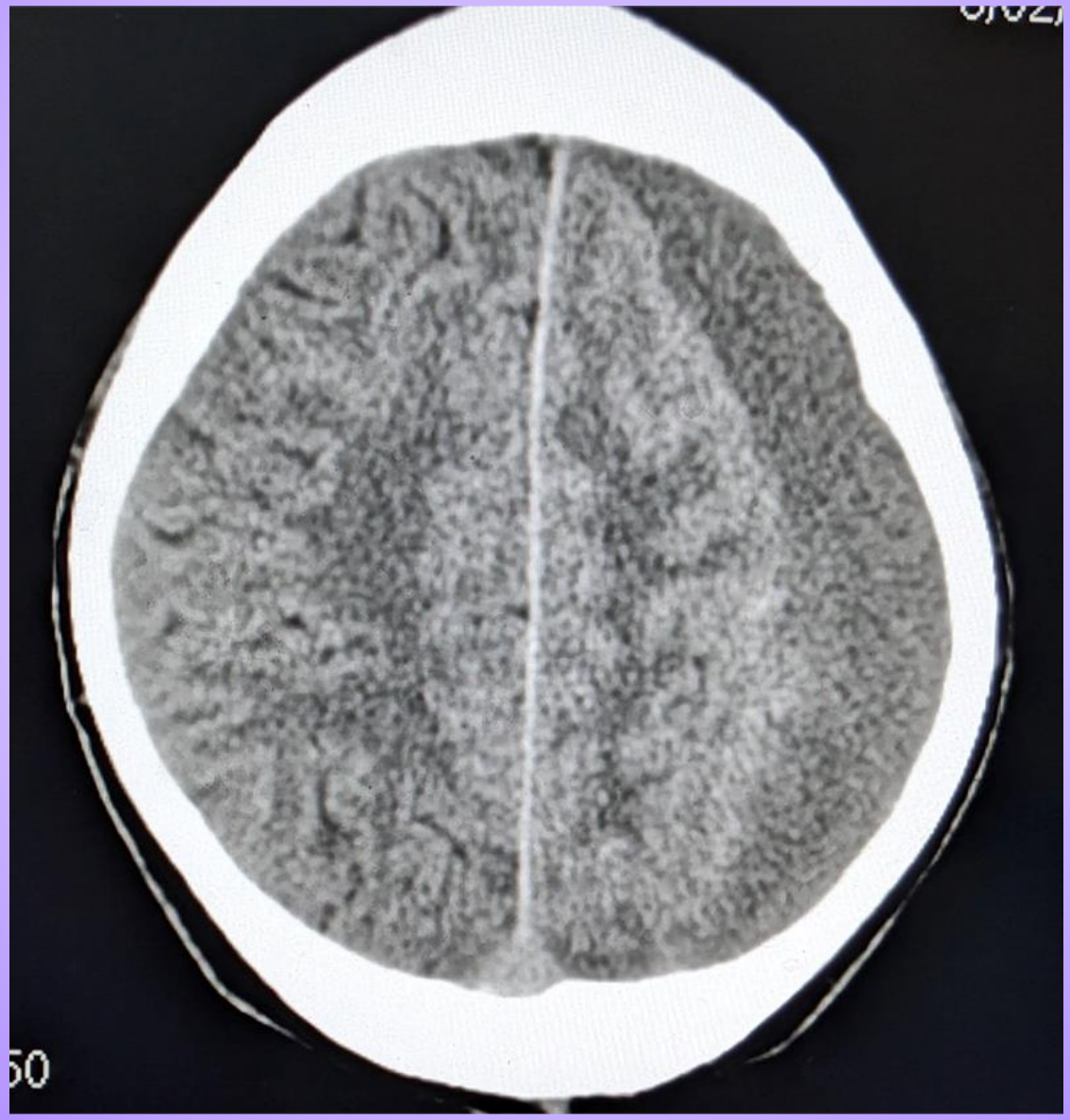
3. Unselected branch embolization



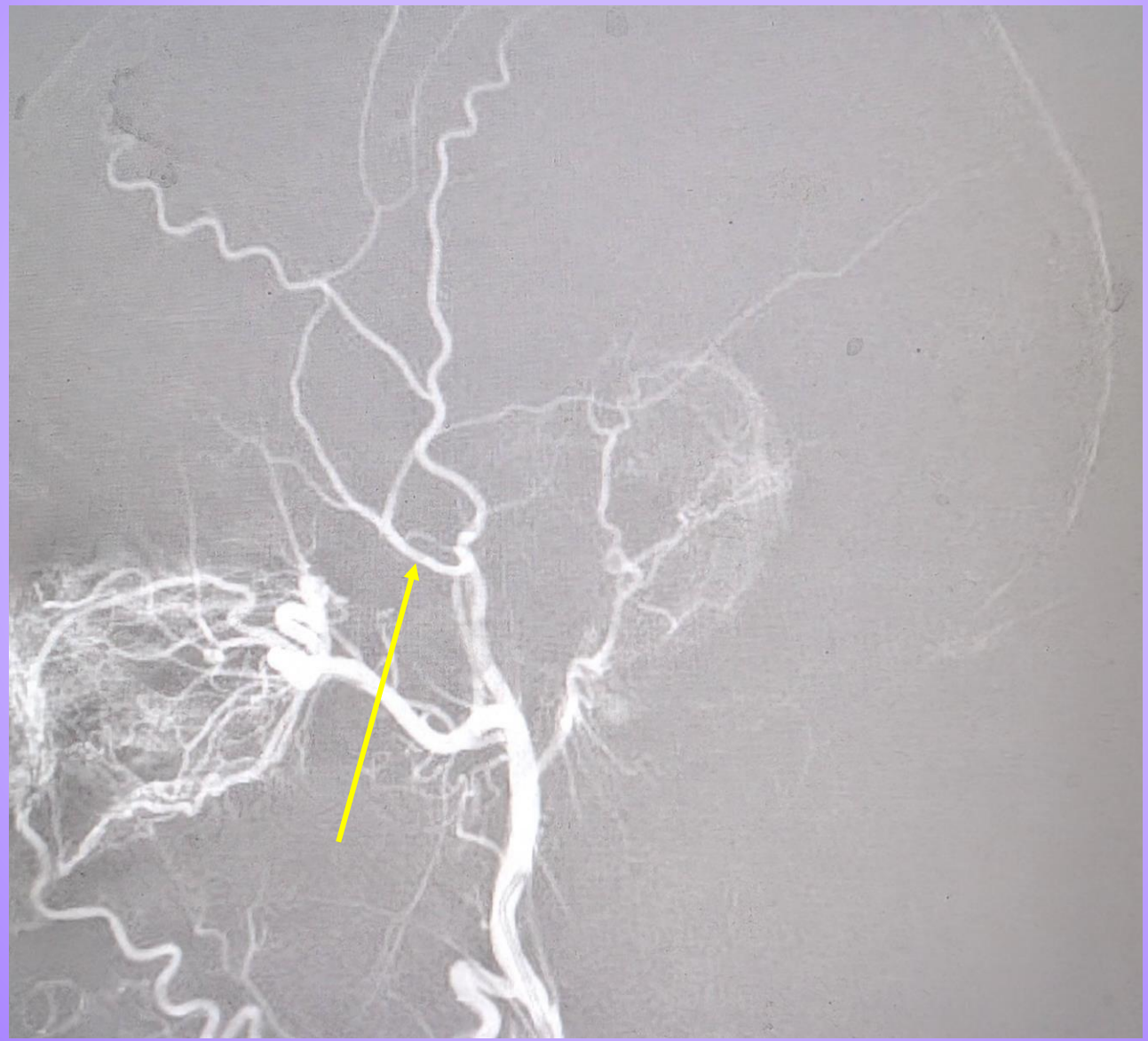
Unselected branch embolization



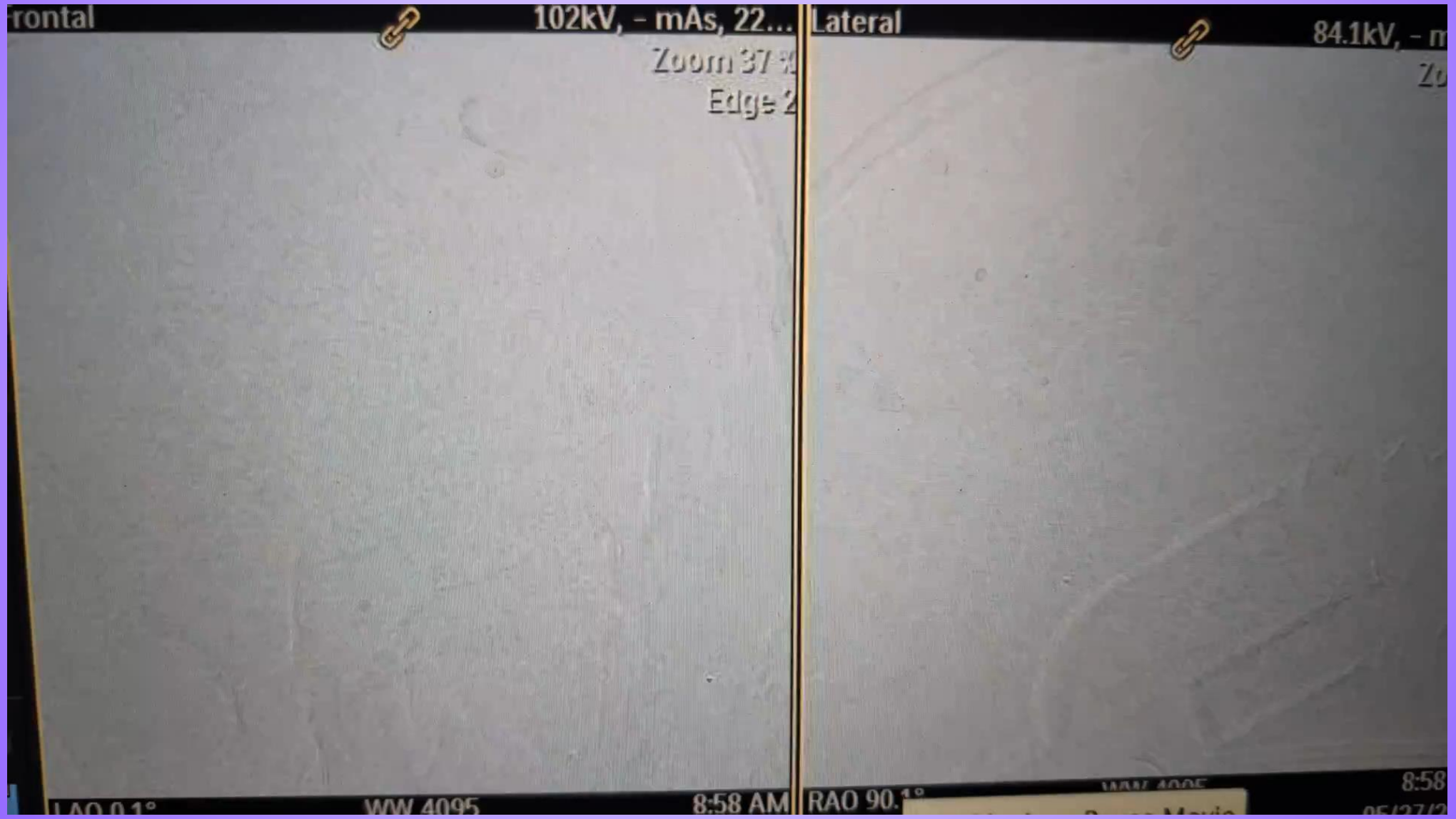
Case example 1: 37M pre-embo NO SURGERY



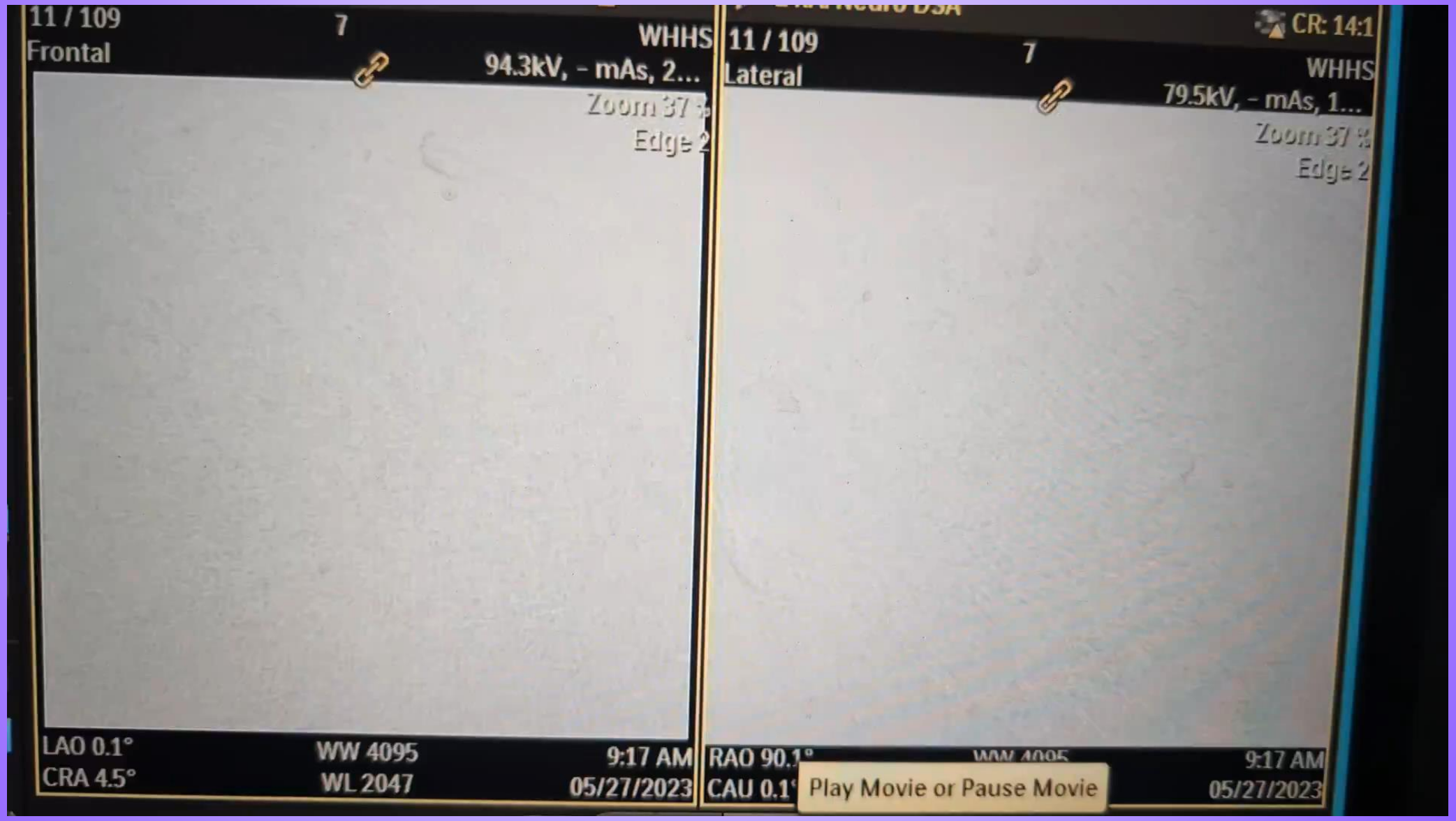
Case example 1: target



Case example 1: superselective microangiography and PVA embolization

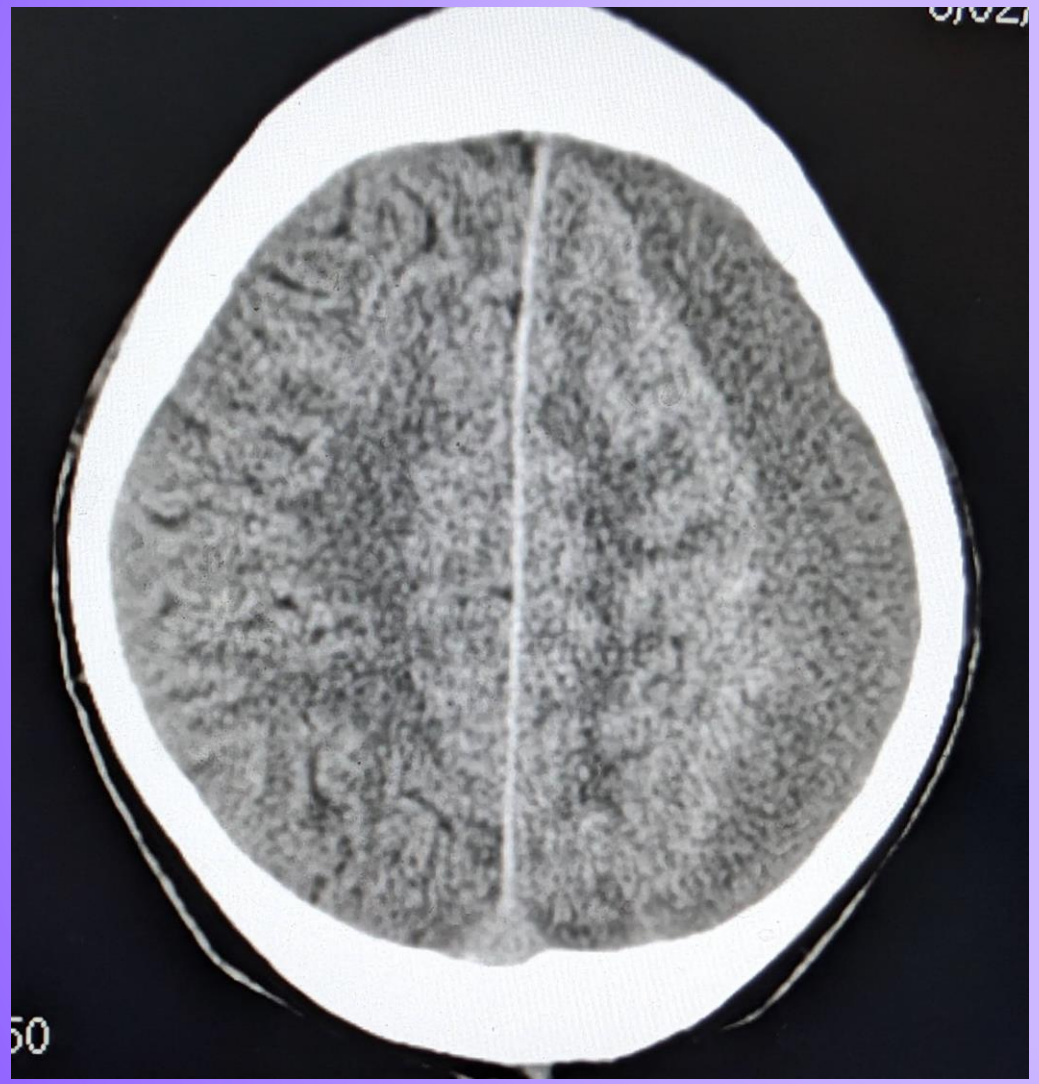


Case example 1 37M NO SURGERY post-embo

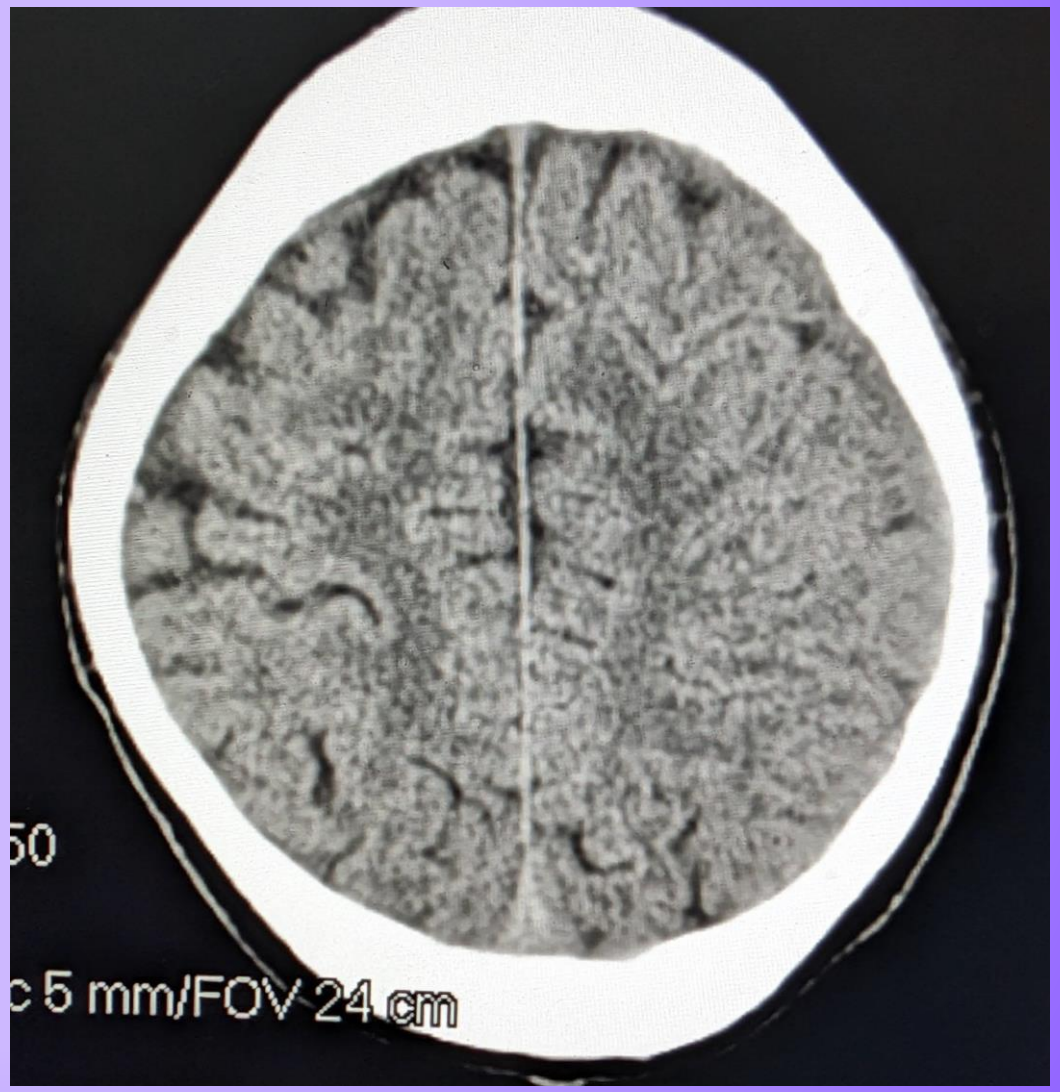


Case example 1 37M NO SURGERY

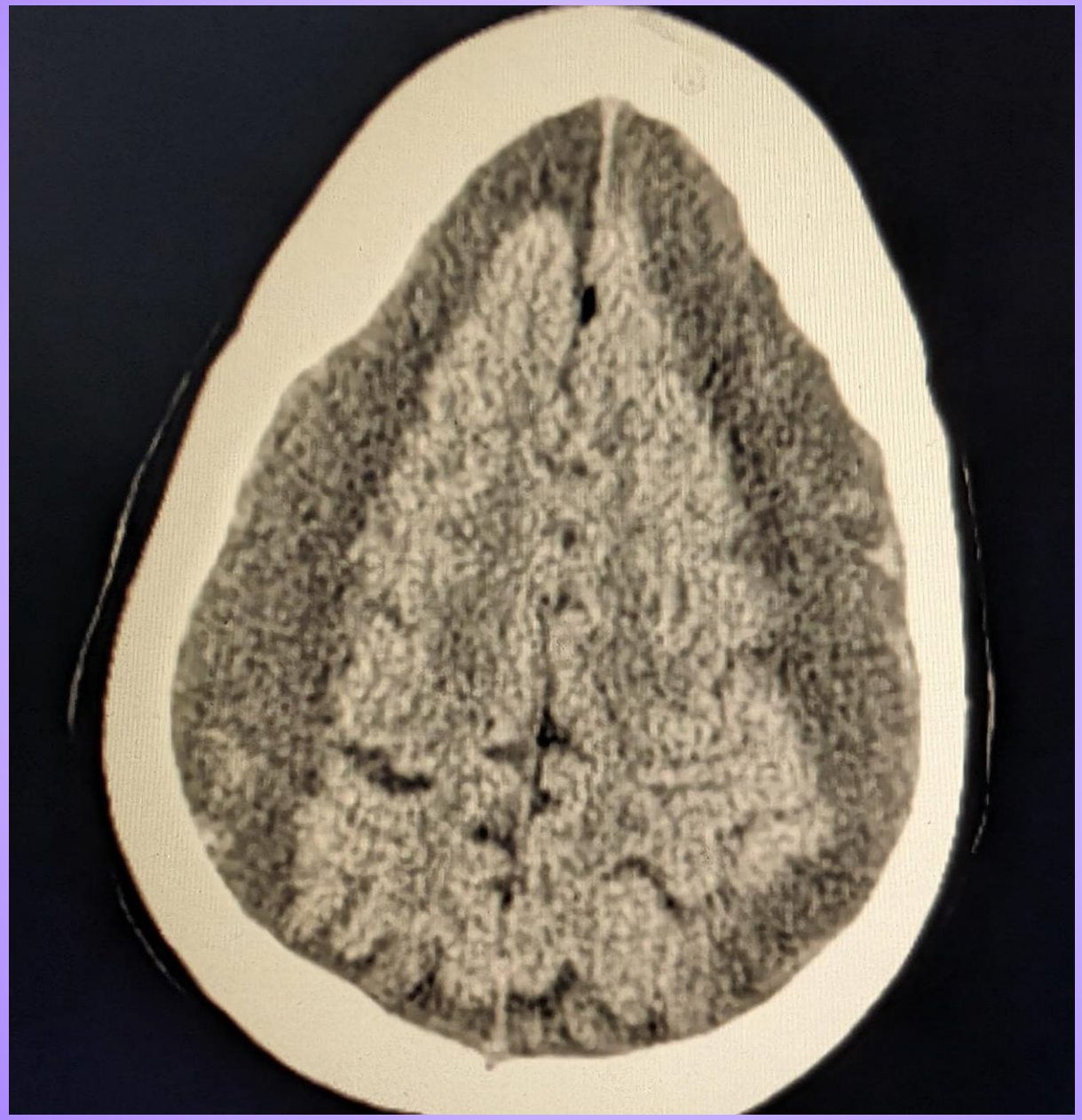
June 22



August 14

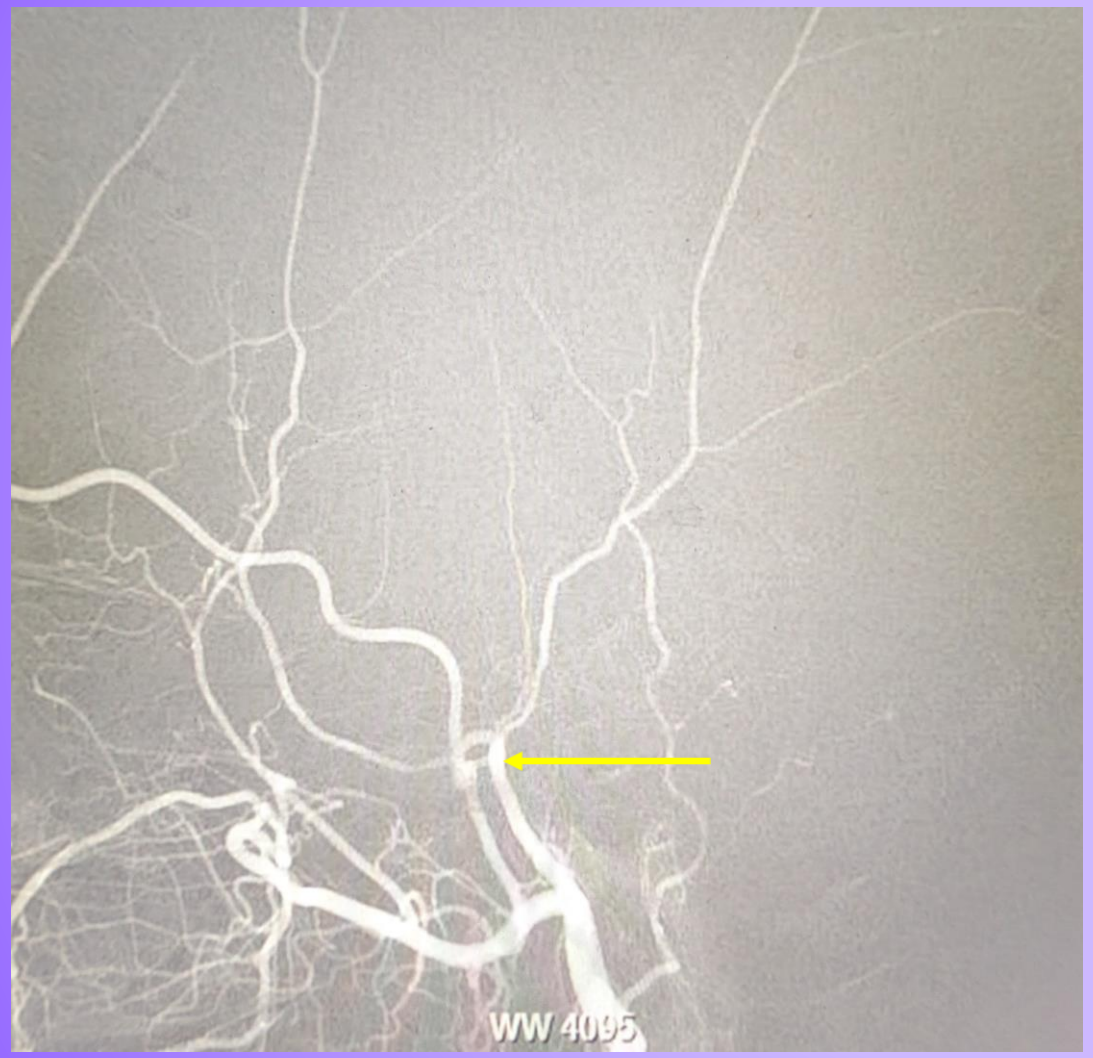


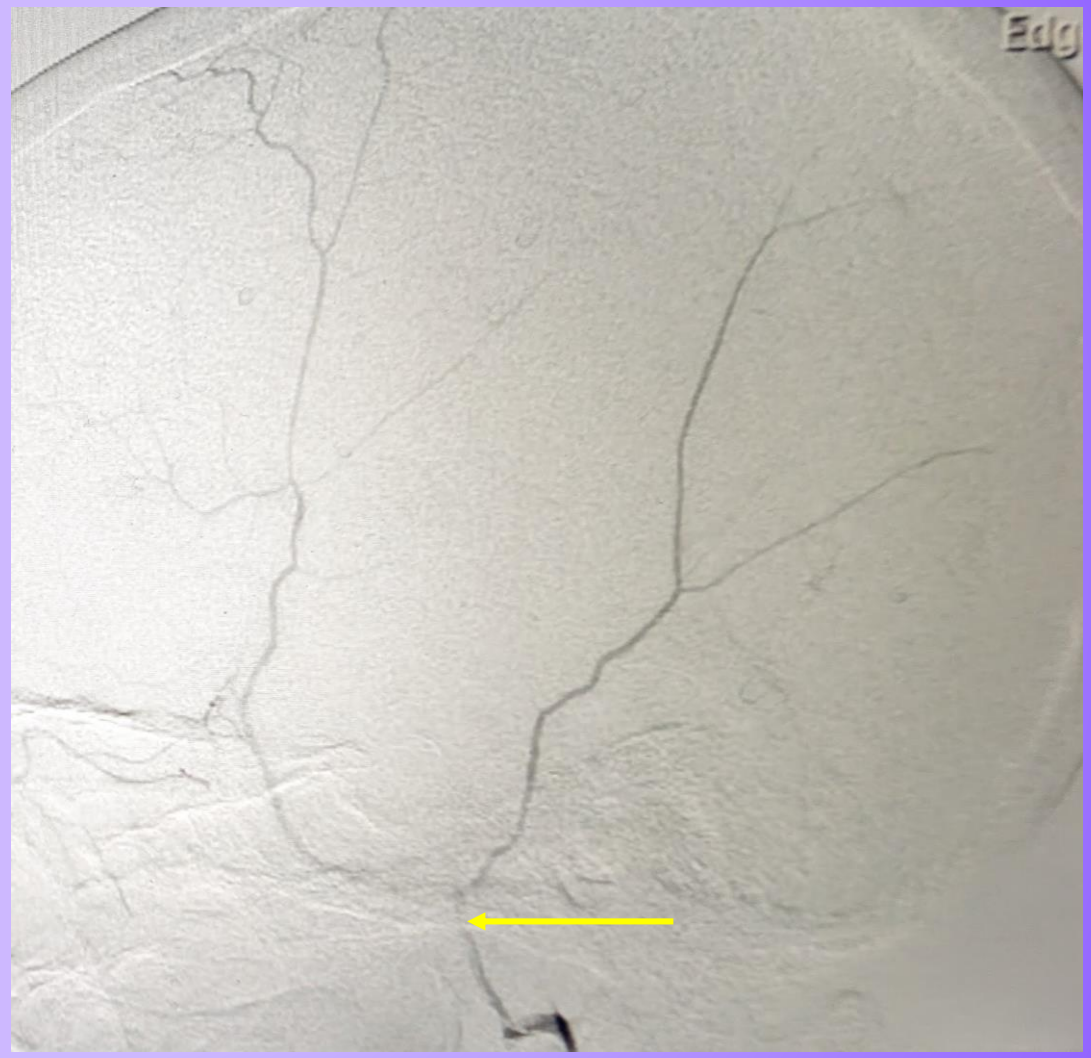
Case example 2: 53F NO SURGERY



Case example 2: 53F Pre-embo external carotid angiography

Case example 2: 53F target and superselective microangiography





Case example 2: 53F NO SURGERY

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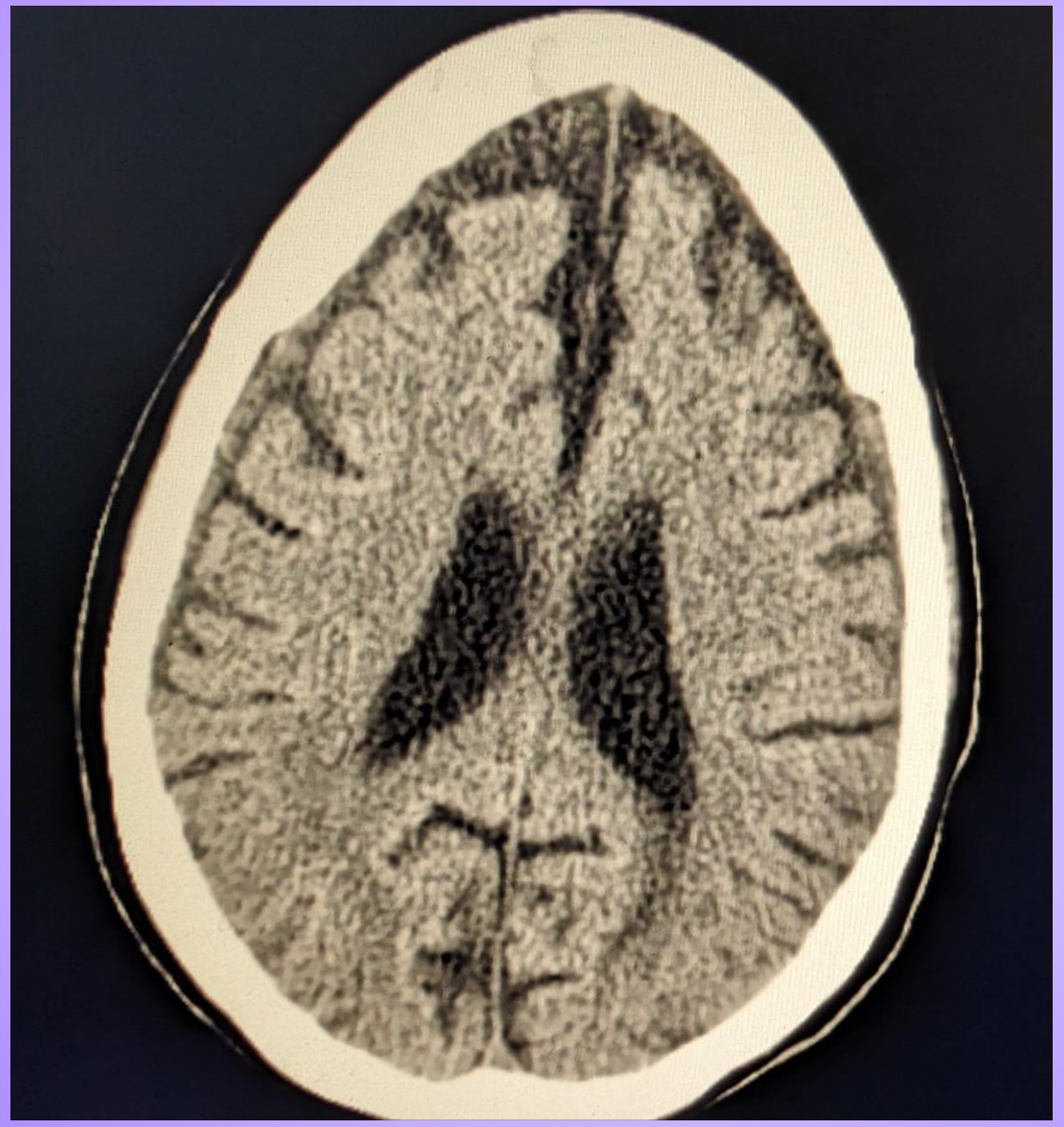

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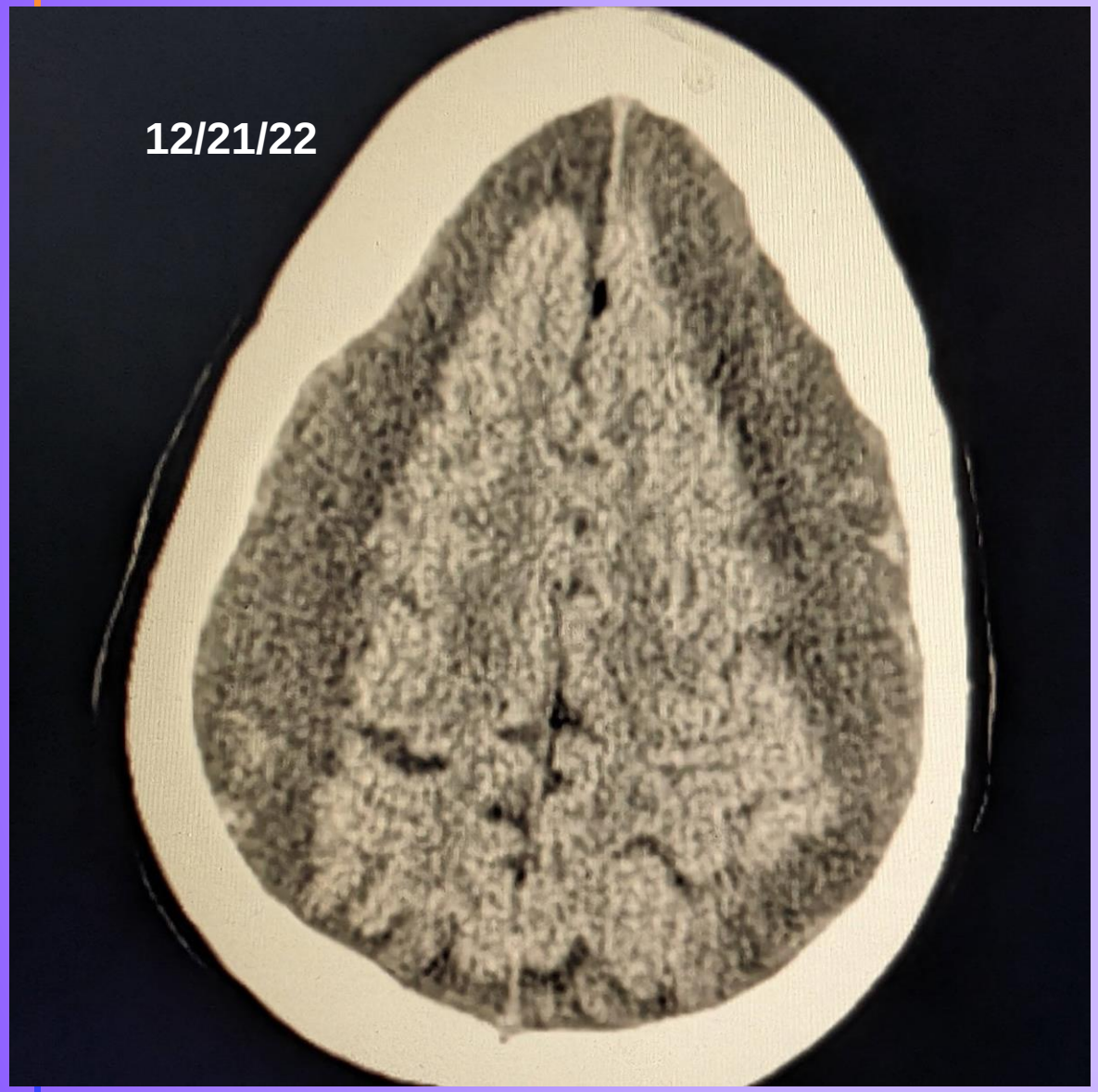
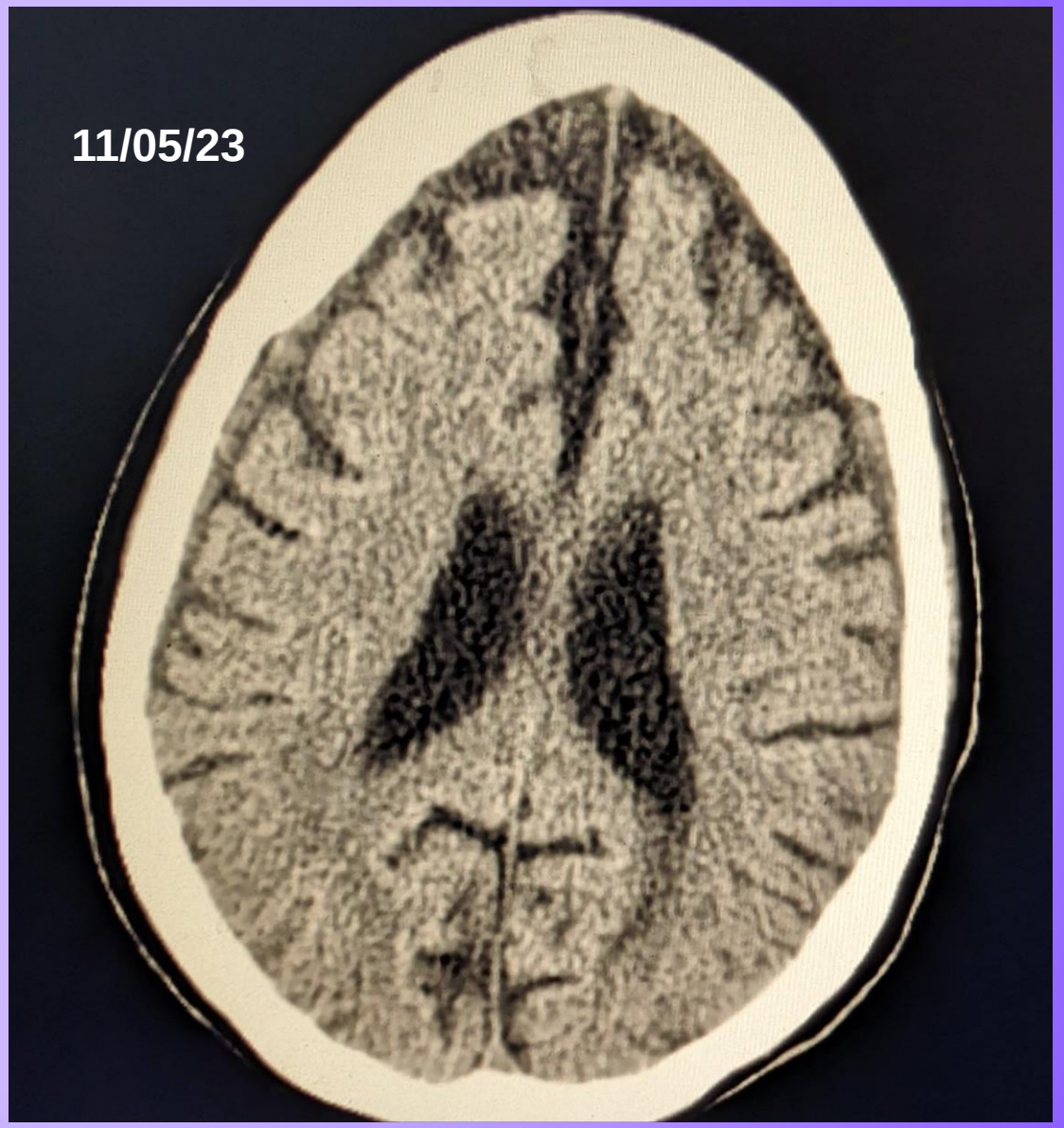
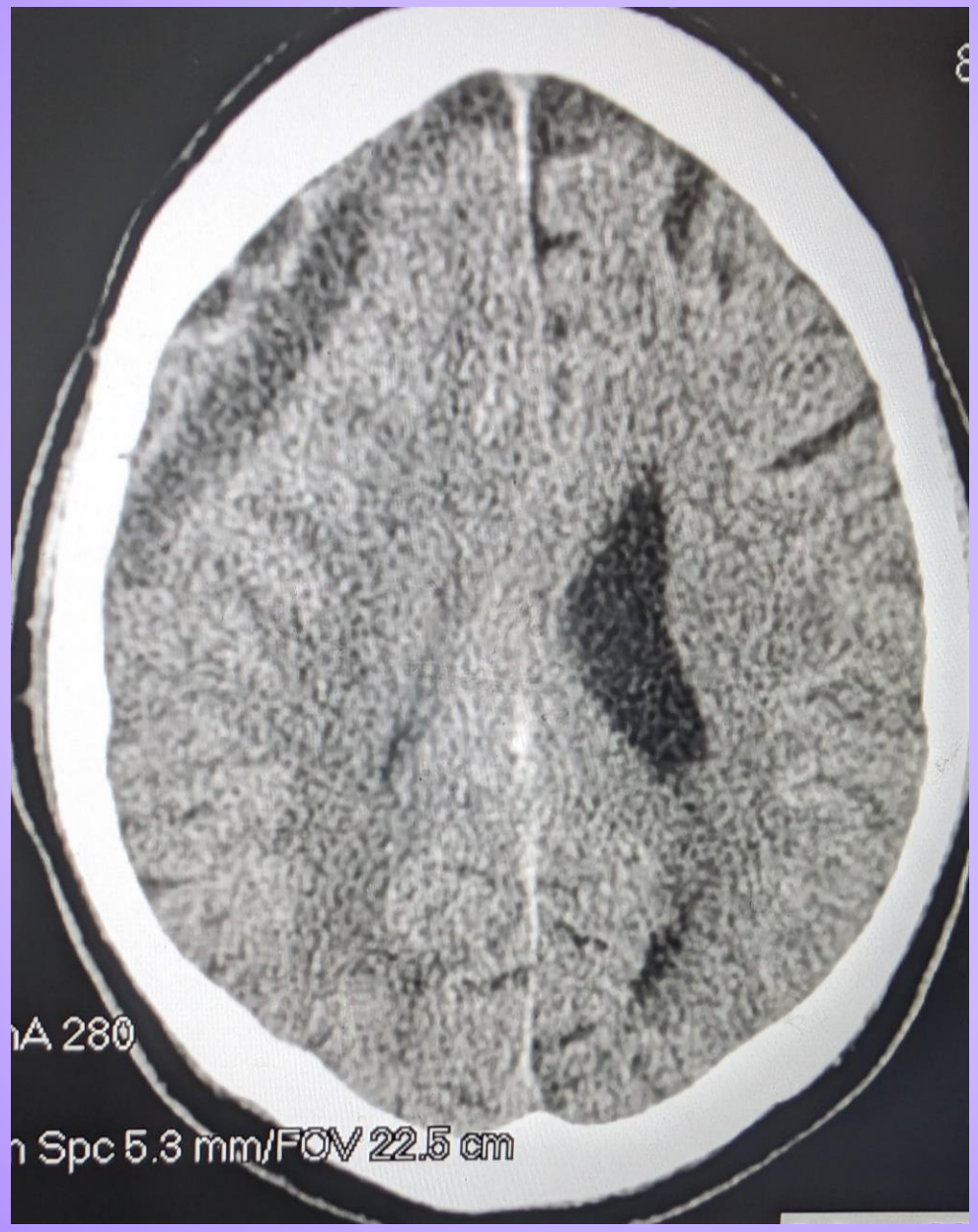
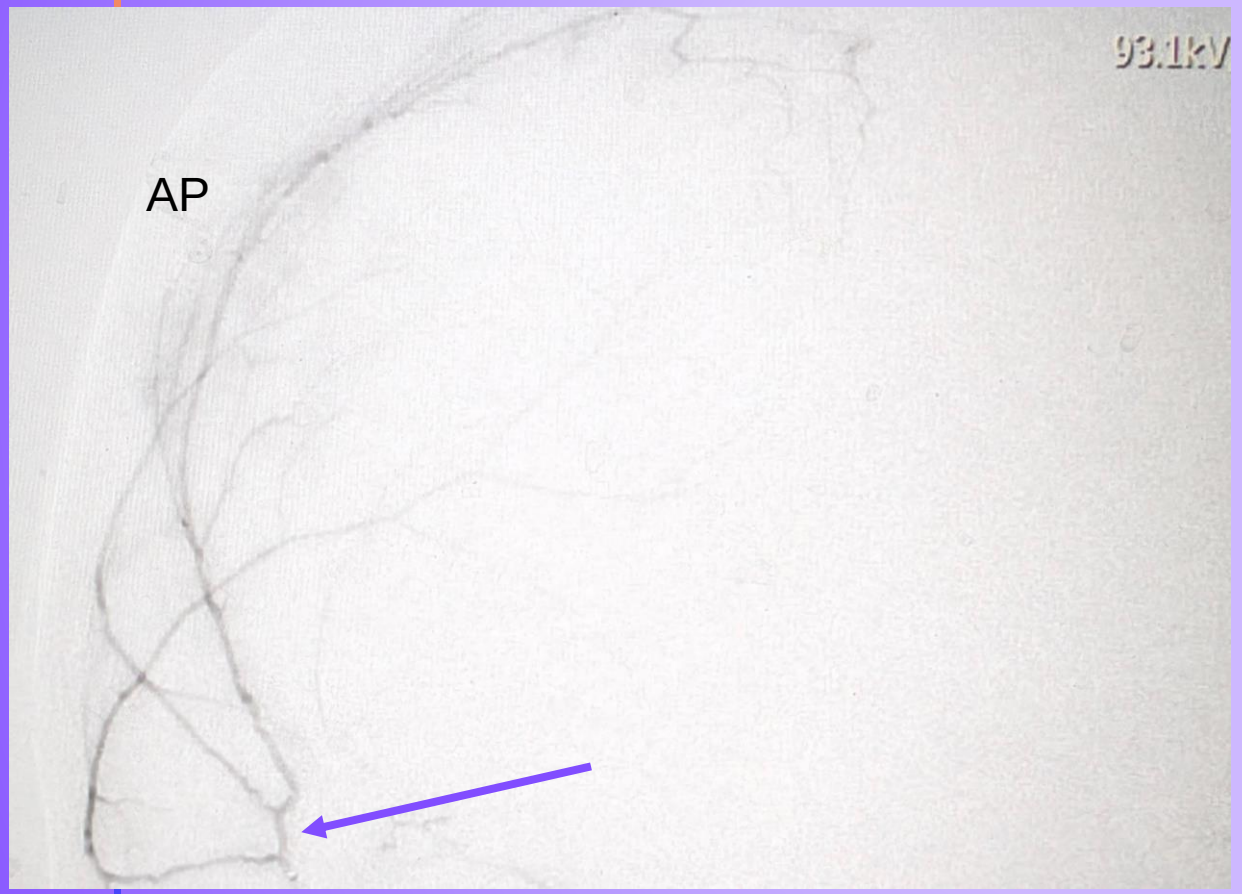


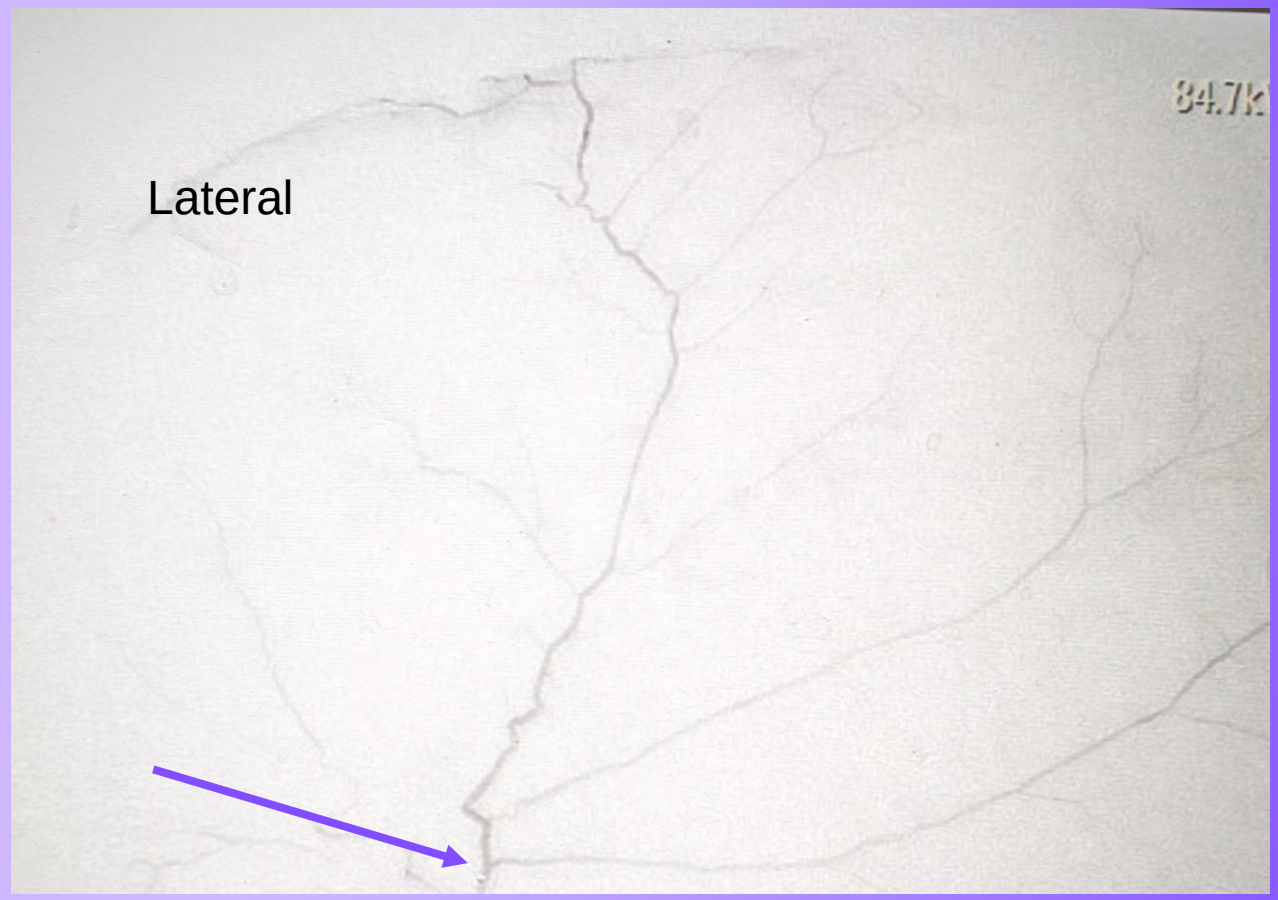


Case example 3: 69M NO SURGERY

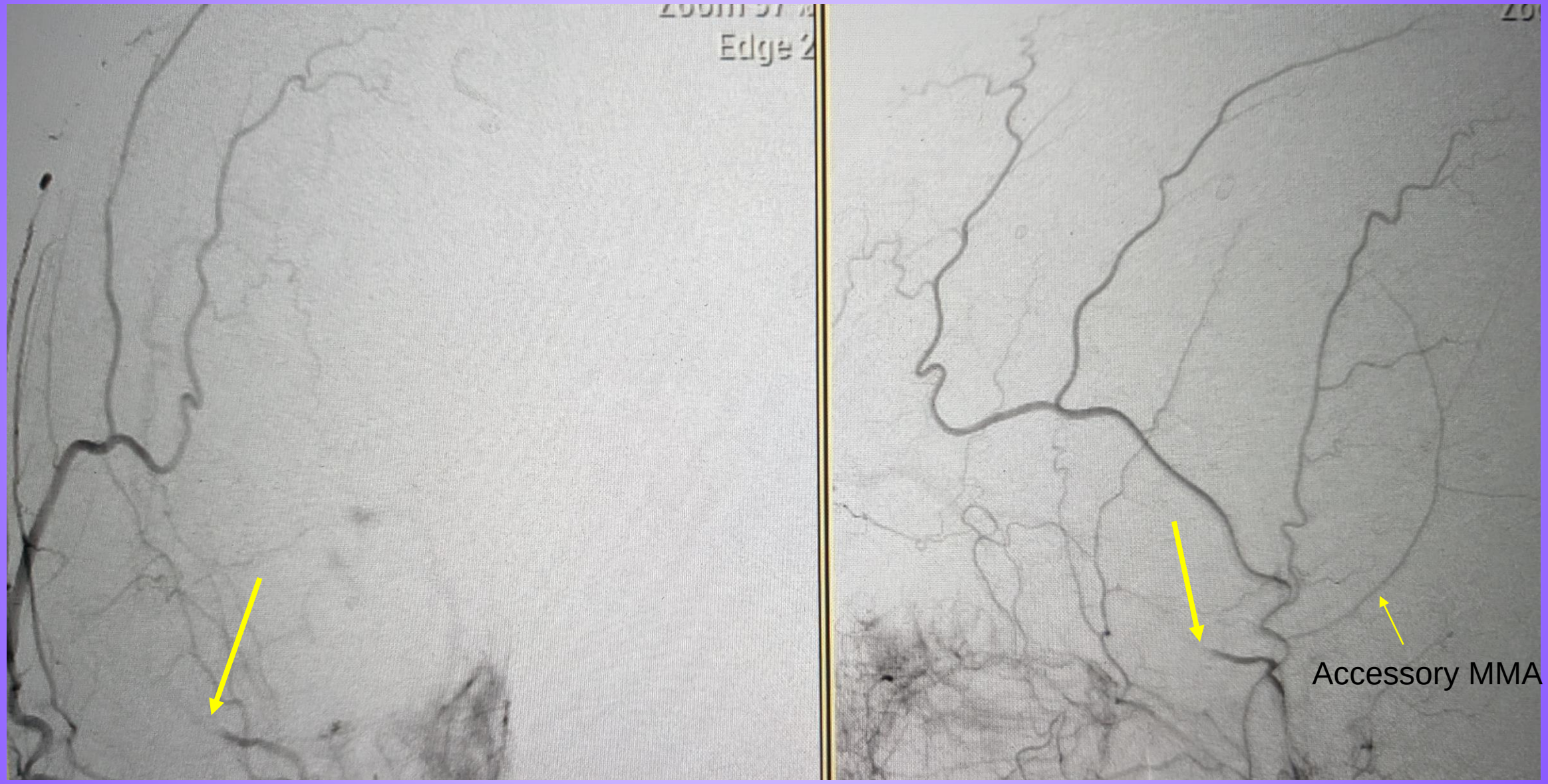


Case example 3: microangiography blush

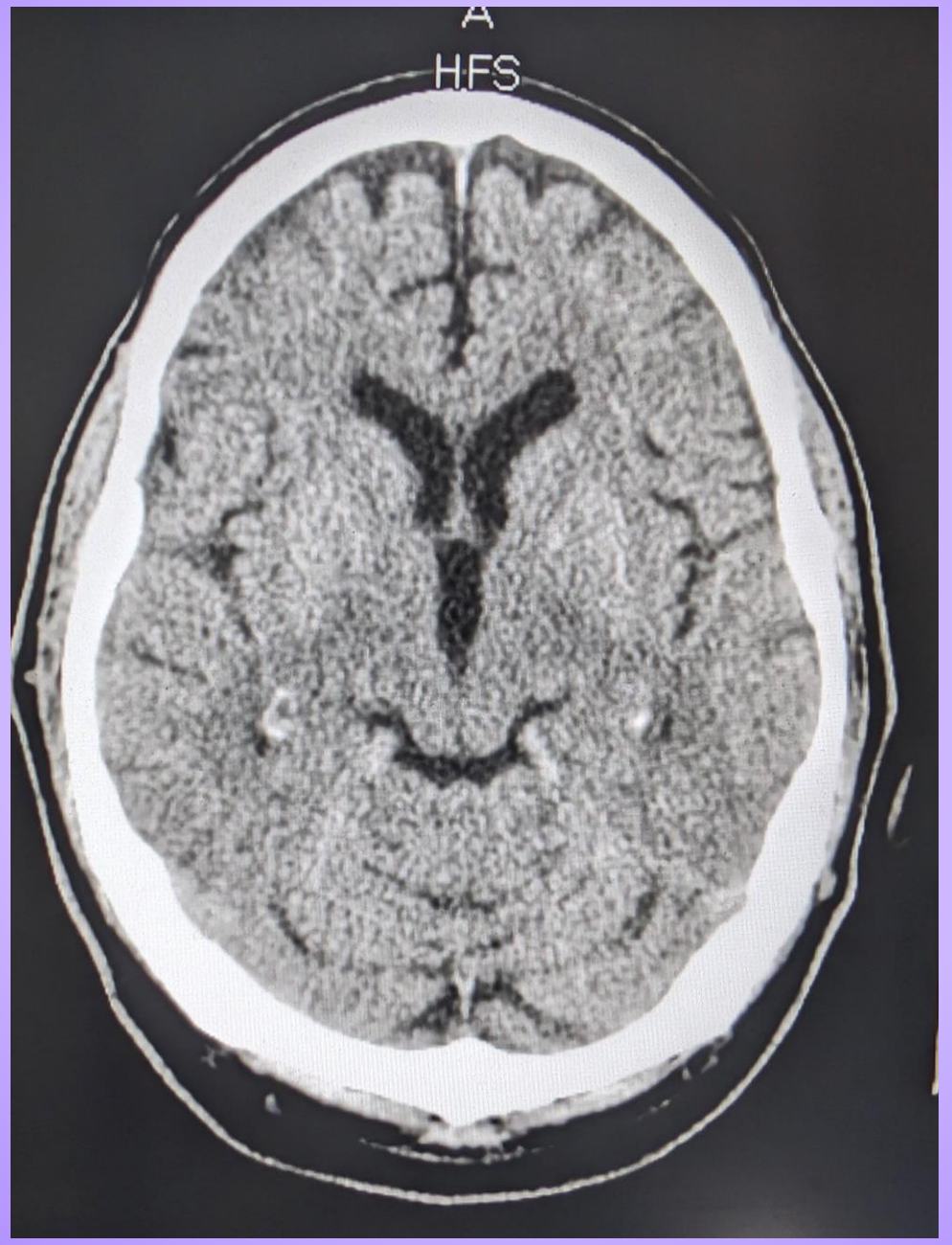




Case example 3: post-embo



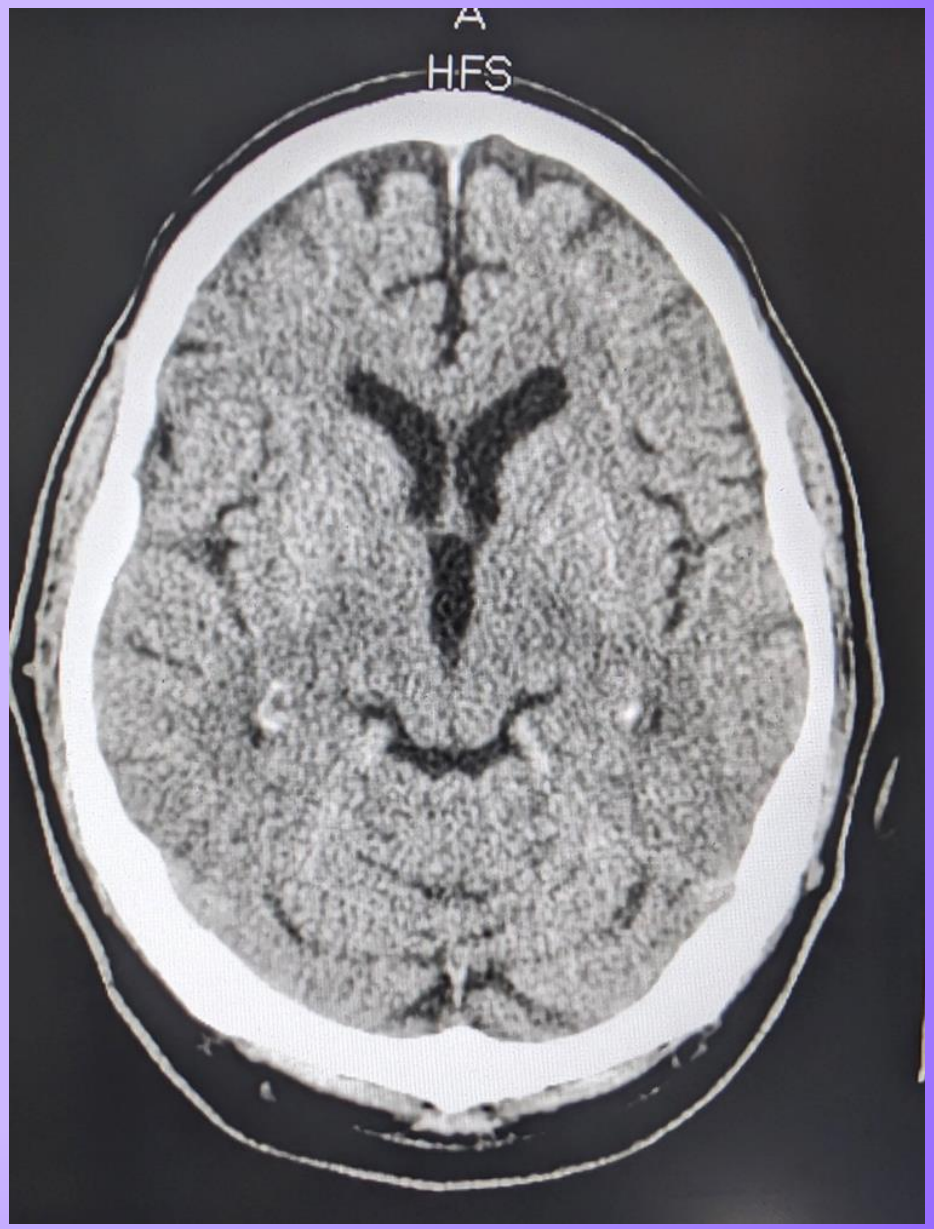
Case example 3: 69M NO SURGERY



Case example 3: 69M NO SURGERY

08/25/23

11/13/23



Questions

Expendable MMA?!

Embolysate selection? Liquid vs particulate, size etc.

Branches? Which?

Proximal vs. distal penetration?

Timing: “perioperative”? Better before or after craniotomy?

Surgery: How often can MMAE make craniotomy unnecessary?

Recanalization/ recurrence?

Preliminary results for MMAE: Washington Hospital

First MMAE: December 2, 2019

35 embolizations in 32 patients

Mean age 73, range 28 - 95 years

Adjunctive (to craniotomy) embolizations: 11

Preoperative embolizations: 1 (noticeable difference in postop drain output)

Standalone embolizations: 24

Average procedure time: 45 minutes (19)

Recurrences: 0

Complications: 1 (asymptomatic femoral artery dissection) 2.8%

Deaths: 0

Radiographic normalization: rule

Answers

Expendable MMA: yes

Embolysate selection: PVA 45-150 micron particles = blush (tumor, epistaxis)

Branches: question is negated by distal penetration of PVA

Proximal vs. distal: the embolization, not the microcatheter position

Timing: “perioperative”

Surgery: MMAE becomes the unexpected nonoperative solution in the majority of cases

Recanalization/ recurrence: none (longer followup required)

Conclusions

Chronic SDH is a complex inflammatory condition resulting from an intracranial bleeding event that evolves into a self-perpetuating cycle of inflammation, fibrinolysis, angiogenesis and further bleeding from a neovascularized outer membrane. Incidence is increasing with 60,000 annual cases in USA by 2030.

Historical management of CSDH has been primarily surgical and inadequate, with a high rate of recurrence (37%), complications and high mortality (20%) in a frail population.

The membrane derives its blood supply primarily or entirely from the ipsilateral MMA.

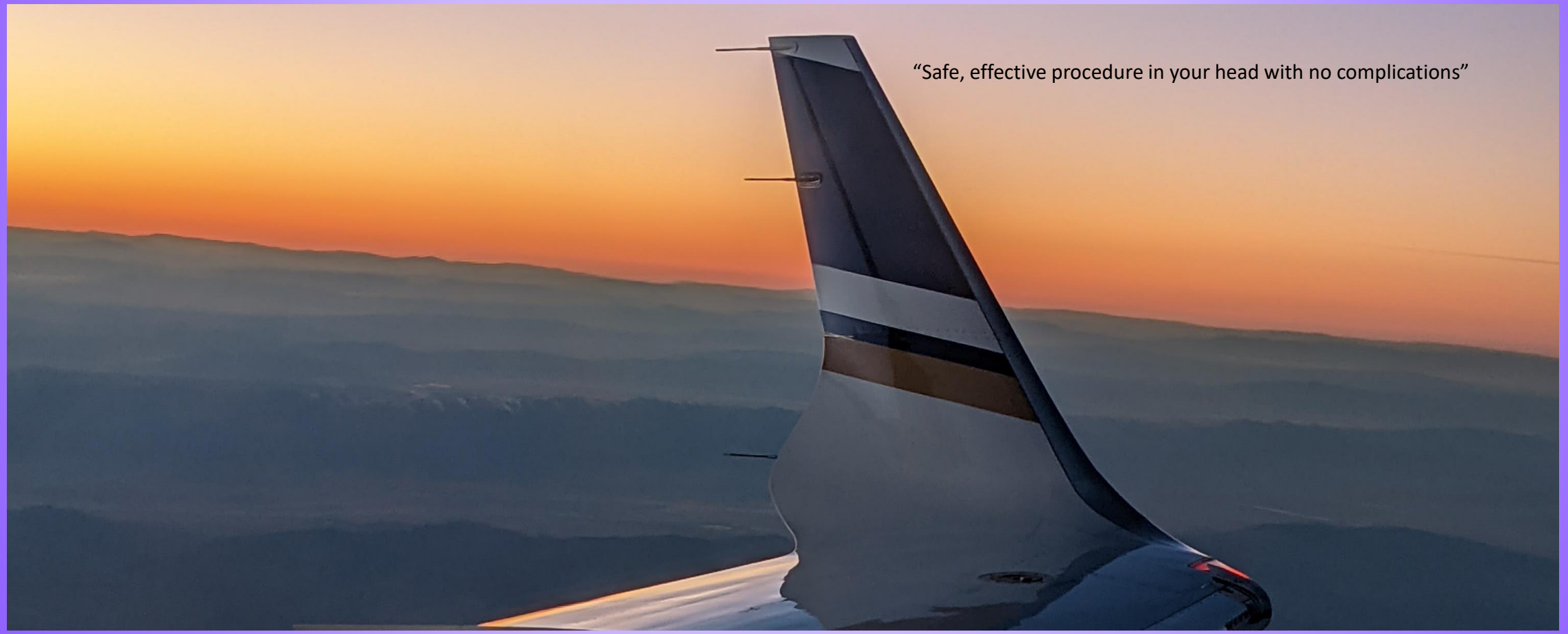
The MMA is expendable.

MMAE is an effective treatment for chronic SDH, with an acceptable margin of safety. It appears to work by breaking the cycle of inflammation and angiogenesis.

Questions remain for optimization of MMAE but branch selection, embolic material and perioperative timing appear inconsequential according to most current studies. The technique of demonstrating the vascular blush (distal **embolysate** penetration) may be associated with more effective embolization and negates the impact of branch selection and distal **microcatheter** penetration.

Superselective MMAE can obviate the need for craniotomy in well selected cases.

Surgery remains a valuable treatment and should not be delayed in a symptomatic patient.


“Safe, effective procedure in your head with no complications”

Prophylaxis?

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JNS

CLINICAL ARTICLE

J Neurosurg 138:1494–1502, 2023

Middle meningeal artery embolization for treatment of chronic subdural hematomas: does selection of embolized branches affect outcomes?

MirHojjat Khorasanizadeh, MD,[1] Max Shutran, MD,[1] Alfonso Garcia, MPH,[1] Alejandro Enriquez-Marulanda, MD,[1] Justin Moore, MD, PhD,[1] Christopher S. Ogilvy, MD,[1] and Ajith J. Thomas, MD[2]

[1]Neurosurgical Service, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts; and [2]Department of Neurological Surgery, Cooper University Health Care, Cooper Medical School of Rowan University, Camden, New Jersey

OBJECTIVE Middle meningeal artery (MMA) embolization (MMAE) is a new therapeutic modality for chronic subdural hematoma (cSDH). There is limited evidence comparing various MMAE procedural techniques, resulting in significant variations in technique and procedural planning. The objective of this study was to compare outcomes of MMAE by the number and location of MMA branches that were embolized.

METHODS A single-center retrospective study of patients with cSDH treated by MMAE was conducted. Clinical outcomes, need for re-intervention, and changes in hematoma size were compared between different MMAE techniques.

RESULTS Ninety-four cSDHs in 78 patients were included. Embolization of the proximal trunk only, distal branches only, or proximal trunk plus distal branches resulted in similar rates of need for rescue surgery (7.4%, 13.0%, and 6.8%, respectively; $p = 0.66$) and rates of reducing the volume of the hematoma by at least 50% (74.1%, 80.0%, and 77.5%, respectively; $p = 0.88$). Embolization of only one branch had similar outcomes to embolization of more than one branch, as rescue surgery rates were 9.3% and 7.8% ($p = 0.80$), and rates ≥ 50% volume reduction were 75.6% and 78.3% ($p = 0.76$), respectively. Selective embolization of the dominant MMA branch was not associated with significantly different outcomes.

CONCLUSIONS Outcomes of distal, proximal, or combined proximal and distal MMAE in cSDH are not significantly different. Embolization of more than one branch is not associated with improved treatment efficacy. Arguably, targeting any location in the MMA provides sufficient flow restriction to enable spontaneous hematoma resolution. Accordingly, a technical planning algorithm for cSDH MMAE is suggested.

https://thejns.org/doi/abs/10.3171/2022.9.JNS221663

KEYWORDS chronic subdural hematoma; middle meningeal artery embolization; technical analysis; ophthalmic anastomoses; endovascular neurosurgery; vascular disorders

Onyx Versus Particles for Middle Meningeal Artery Embolization in Chronic Subdural Hematoma

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BACKGROUND: Middle meningeal artery (MMA) embolization has recently emerged as a treatment option for chronic subdural hematoma (cSDH). It is considered a simple and potentially safe endovascular procedure.

OBJECTIVE: To compare between 2 different embolic agents; onyx (ethylene vinyl alcohol) and emboparticles (polyvinyl alcohol particles—PVA) for endovascular treatment of cSDH.

METHODS: A retrospective analysis of all patients who underwent MMA embolization for cSDH treatment in 2 comprehensive centers between August 2018 and December 2021. Primary outcomes were failure of embolization and need for rescue surgical evacuation.

RESULTS: Among 97 MMA embolizations, 49 (50.5%) received onyx and 48 (49.5%) received PVA. The presence of acute or subacute on cSDH was higher in the PVA group 11/49 (22.5%) vs 30/48 (62.5%), respectively, $P < .001$. There were no significant differences between both groups regarding failure of embolization 6/49 (12.2%) vs 12/48 (25.0%), respectively, $P = .112$, and need of unplanned rescue surgical evacuation 5/49 (10.2%) vs 8/48 (16.7%), respectively, $P = .354$. Hematoma thickness at late follow-up was significantly smaller in the PVA group 7.8 mm vs 4.6 mm, respectively; $P = .017$.

CONCLUSION: Both onyx and PVA as embolic agents for cSDH can be used safely and have comparable clinical and surgical outcomes.

KEY WORDS: Chronic subdural hematoma, Emboparticles, Middle meningeal artery embolization, Onyx

Neurosurgery 00:1–7, 2022

https://doi.org/10.1227/neu.0000000000002307

...the border layer of dura.[4,5] However, the path-

Middle Meningeal Artery Embolization for Chronic Subdural Hematoma: A Review

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Received, November 16, 2022; **Accepted,** December 13, 2022; **Published Online,** March 10, 2023.

Middle meningeal artery embolization (MMAE) for chronic subdural hematomas (cSDHs) has evolved as a potential treatment alternative for these lesions. The indications for using this treatment modality and the pathophysiology of cSDHs are an area of considerable interest. A retrospective review was performed including all major papers addressing this topic. Although considered a relatively new treatment option, MMAE for cSDHs is gaining widespread popularity. There are many questions that need to be addressed regarding its indications, some of which are the subject of ongoing clinical trials. The efficacy of this treatment modality in carefully selected patients has also provided new insights into the potential pathophysiology of cSDHs. This concise review will focus on the current evidence supporting the use of embolization in the treatment of this disease and highlight unanswered relevant clinical questions regarding MMAE indications and technique.

KEY WORDS: Middle meningeal artery embolization, Subdural hematoma

Operative Neurosurgery 00:1–7, 2023

https://doi.org/10.1227/ons.0000000000000656

Chronic subdural hematoma (cSDH) is a common neurological disorder primarily affecting older people and has long been ... inflammation, angiogenesis, and the resultant development of subdural neomembranes.[16,17]

EMBOSPHERES

Cureus

Open Access Original Article

DOI: 10.7759/cureus.47293

Middle Meningeal Artery Embolization for the Management of Chronic Subdural Hematoma

Balakrishna Aggipothu [1], Saikanth Deepalam [2], Sagar Badachi [3], Prabakaran Palanisamy [4], Sharath Kumar GG [5], Harshith Kramadhari [5], Gurtej singh Sardar [4], Thomas Mathew [3], Ragunandan Nadig [3], GRK Sarma [6]

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Review began 10/04/2023
Review ended 10/11/2023
Published 10/18/2023

Abstract

Introduction

Chronic subdural hematoma (cSDH) results from neovascularization of the subdural capsular membrane and embolization of the Middle Meningeal Artery (MMA) helps inhibit the same and prevent recurrence.

Materials and methods

We retrospectively reviewed the endovascular management for chronic SDH in 29 patients between 2018 to 2022. The parameters analyzed were clinical history, radiologic imaging findings, procedure details, and angiographic and clinical outcomes.

Results

Twenty-nine MMA embolization procedures were done. Follow-up MRI or CT done in 28 subjects, showed complete resolution in 25 patients and a significant reduction in bilateral SDH in three patients. One patient died due to renal failure and aspiration pneumonia-related complications. Ninety days mRS (modified Rankin scale) was 0 in 25 patients (86%), one in two patients, and two in one patient.

Conclusions

MMA embolization for chronic SDH is a feasible, safe, and effective technique in patients with chronic and recurrent SDH.

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CLINICAL ARTICLE

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Operative Neurosurgery 00:1–7, 2023 https://doi.org/10.1227/ons.0000000000000656

Middle Meningeal Artery Embolization Versus Conventional Management for Patients With Chronic Subdural Hematoma: A Systematic Review and Meta-Analysis

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This paper was presented at the 2022 Congress of Neurological Surgeons Annual Meeting, San Francisco, CA.

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Received, September 28, 2022; **Accepted,** November 15, 2022; **Published Online,** March 17, 2023.

BACKGROUND: The results from studies that compare middle meningeal artery (MMA) embolization vs conventional management for patients with chronic subdural hematoma are varied.

OBJECTIVE: To conduct a systematic review and meta-analysis on studies that compared MMA embolization vs conventional management.

METHODS: Medline, PubMed, and Embase databases were searched. Primary outcomes were treatment failure and surgical rescue; secondary outcomes were complications, follow-up modified Rankin scale > 2, mortality, complete hematoma resolution, and length of hospital stay (day). The certainty of the evidence was determined using the GRADE approach.

RESULTS: Nine studies yielding 1523 patients were enrolled, of which 337 (22.2%) and 1186 (77.8%) patients received MMA embolization and conventional management, respectively. MMA embolization was superior to conventional management for treatment failure (relative risk [RR] = 0.34 [0.14-0.82], $P = .02$), surgical rescue (RR = 0.33 [0.14-0.77], $P = .01$), and complete hematoma resolution (RR = 2.01 [1.10-3.68], $P = .02$). There was no difference between the 2 groups for complications (RR = 0.93 [0.63-1.37], $P = .72$), follow-up modified Rankin scale >2 (RR = 0.78 [0.449-1.25], $P = .31$), mortality (RR = 1.05 [0.51-2.14], $P = .89$), and length of hospital stay (mean difference = −0.57 [−2.55, 1.41], $P = .57$). For MMA embolization, the number needed to treat for treatment failure, surgical rescue, and complete hematoma resolution was 7, 9, and 3, respectively. The certainty of the evidence was moderate to high for primary outcomes and low to moderate for secondary outcomes.

CONCLUSION: MMA embolization decreases treatment failure and the need for surgical rescue without furthering the risk of morbidity and mortality. The authors recommend considering MMA embolization in the chronic subdural hematoma management.

KEY WORDS: Chronic subdural hematoma, Middle meningeal artery, Embolization, Burr-hole, Craniotomy, Meta-analysis

https://doi.org/10.1227/neu.0000000000002365

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