JOURNAL OF NEUROSURGERY:
Case Lessons

J Neurosurg Case Lessons 9(3): CASE24607, 2025
DOI: 10.3171/CASE24607

Retrograde thrombosis of the superficial sylvian vein following liquid adhesive hemostat use during craniotomy: illustrative case

Gabrielle E. A. Hovis, BS,[1] Jordan Davies, MD,[1] Joseph Lockwood, MD,[1,2] and Frank P. K. Hsu, MD, PhD[1]

[1]Department of Neurosurgery, University of California, Irvine, Orange, California; and [2]Department of Neurosurgery, Tulane University, New Orleans, Louisiana

BACKGROUND Intravascular injection of liquid adhesive hemostats is a rare but serious complication that can result in cerebral thromboembolism.

OBSERVATIONS A 64-year-old female underwent orbitozygomatic craniotomy for posterior communicating artery aneurysm clipping with the routine use of a flowable hemostatic agent during extradural dissection. After placement of the aneurysm clip, flow was confirmed through the parent vessel and nearby branches. On postoperative day 1, the patient was found to have superficial middle cerebral vein thrombosis with retrograde embolization and subsequent hemorrhagic infarction of the temporal lobe.

Eight prior cases of intracranial infarction or hemorrhage secondary to thrombosis with intravascular liquid adhesive were identified. With a craniotomy approach, the transverse and sigmoid sinuses were the most common sites of thrombosis, and the vertebral and basilar arteries had the highest incidence of thrombosis after cervical fusion.

LESSONS Intravascular injection of liquid adhesive agents can result in cerebral venous thrombosis, typically of a dural venous sinus. This may present following retrograde embolization, which has not previously been reported. The choice of hemostat, surgical approach, nearby vasculature, and anatomical variations should be carefully considered in the operative management of neurosurgical patients.

https://thejns.org/doi/abs/10.3171/CASE24607

KEYWORDS liquid adhesive hemostat; cerebral venous thrombosis; superficial middle cerebral vein; craniotomy; intracranial hemorrhage

Hemostatic agents have reduced the need for blood transfusion[1] and improved operative times.[2] Various forms of hemostats are available for surgical use, including adhesive hemostats, which act at the fibrin formation step at the end of the coagulation cascade; mechanical hemostats, which promote platelet activation and aggregation for clot formation; and sealants, which are liquids of low viscosity that form a solid film.[3] Adhesive hemostats are further characterized into liquid fibrin and fibrin patches, and both types consist of human-purified fibrinogen and/or thrombin.[3]

Liquid fibrin adhesive agents have been shown to improve the efficacy of and time to hemostasis relative to a mechanical hemostat, along with the minimization of blood loss in the case of vascular insult.[3,4] This is particularly useful in cranial surgery, during which failure to achieve hemostasis can result in critical complications.[1] It is important to note that intravascular injection of liquid adhesive hemostats should be avoided due to the high risk of thromboembolism.[1,3] This is a rare but serious complication that, in the case of cerebrovascular involvement, can result in thrombosis, intracranial infarction and/or hemorrhage, and death.

We present a unique report of inadvertent intravascular administration of liquid fibrin adhesive resulting in superficial middle cerebral vein (SMCV) thrombosis with retrograde embolization and subsequent intracranial hemorrhage (ICH).

Illustrative Case

A 64-year-old female with a history of hypertension presented to the emergency department with right ptosis and blurry vision. The patient reported a 6-month history of periorbital pain and blurry vision in her right eye, which had worsened in the week leading up to her presentation. She also described 1 week of severe, right retro-orbital headaches and neck pain. On examination, she had right ptosis, a dilated and sluggishly reactive right pupil, and restricted upward gaze in the right eye. Her complete blood count, basic metabolic panel, and

ABBREVIATIONS CT = computed tomography; CTA = computed tomography angiography; ICH = intracranial hemorrhage; ICP = intracranial pressure; PComA = posterior communicating artery; SMCV = superficial middle cerebral vein.

INCLUDE WHEN CITING Published January 20, 2025; DOI: 10.3171/CASE24607.
SUBMITTED September 7, 2024. **ACCEPTED** November 12, 2024.

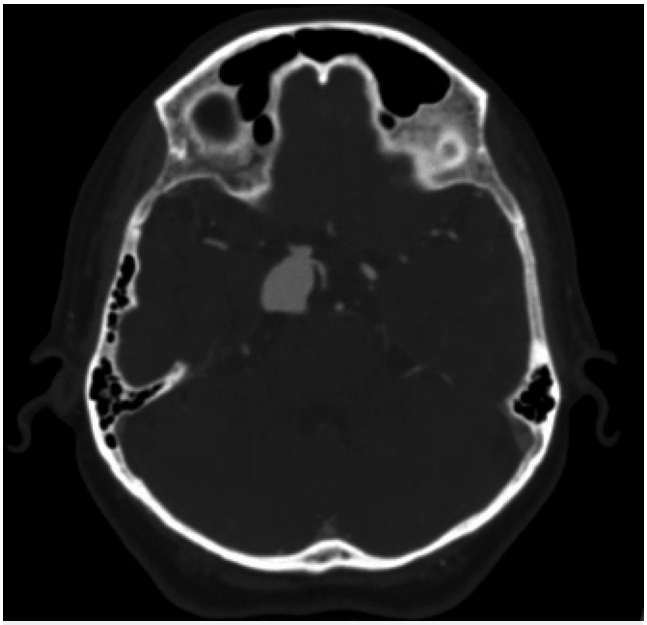

FIG. 1. Preoperative CTA scan demonstrating a 2.0 × 1.5 × 1.5–cm, unruptured, right PComA aneurysm.

coagulation laboratory values were within normal limits. A computed tomography angiography (CTA) scan on the day of admission demonstrated a large, unruptured, right posterior communicating artery (PComA) aneurysm of approximately 2.0 × 1.5 × 1.5 cm (Fig. 1). A diagnostic cerebral angiogram confirmed the finding and identified the pertinent branching vessels (Fig. 2A).

Two days following admission, a right orbitozygomatic craniotomy for clipping of the right PComA aneurysm was performed per institutional procedure with the use of an intraoperative microscope and neuromonitoring. During extradural skull base dissection of the sphenoid bone, for improved visualization and minimized retraction of the brain during the intradural portion, an attempt to release the dural attachments resulted in bleeding resistant to bipolar electrocautery. Floseal, Gelfoam, and cottonoid patties were applied, with unsuccessful hemostasis. Hemostasis was achieved after the application of additional Floseal and Gelfoam. Upon dural opening, a large pale cerebral vein was shown to be intact (Fig. 3A). After appropriate dissection,

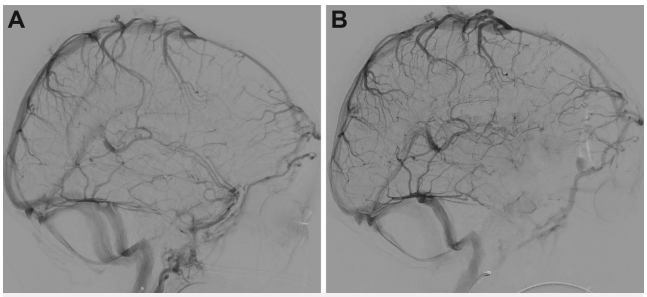

FIG. 2. A: Preoperative diagnostic cerebral angiogram demonstrating right PComA aneurysm. **B:** Postoperative cerebral angiogram demonstrating impeded flow through the sylvian vein into the deep venous system.

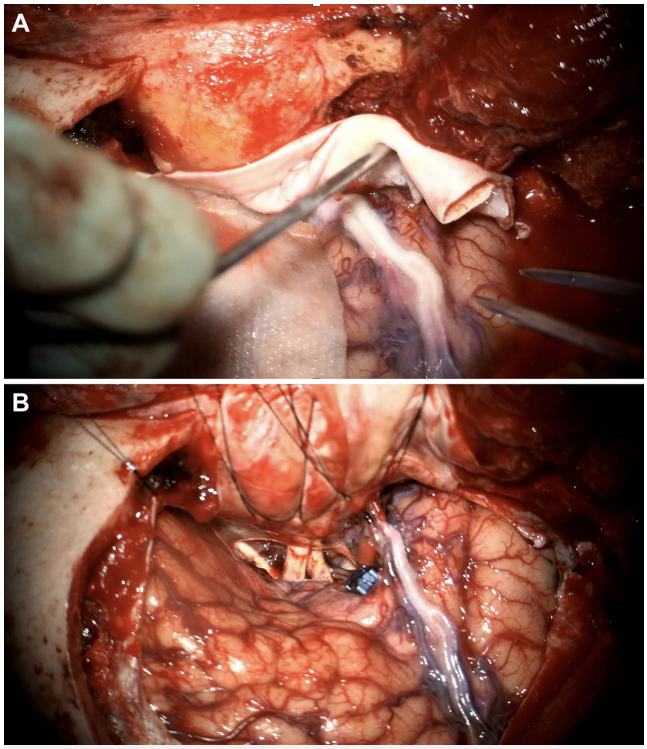

FIG. 3. A: An intact, pale cerebral vein is visualized on dural opening. **B:** A straight, 25-mm permanent aneurysm clip was placed across the right PComA aneurysm. Flow through the parent vessel and nearby branches was confirmed using Doppler and indocyanine green.

a straight 25-mm permanent aneurysm clip was placed across the aneurysm (Fig. 3B), and arterial flow was confirmed through the parent vessel and nearby branches with Doppler and indocyanine green. The total estimated intraoperative blood loss was 100 mL. There was no temporal lobe swelling or contusion seen during the closure of the case, and the bone was safely replaced.

The patient underwent routine postoperative diagnostic cerebral angiography to confirm successful aneurysm clipping and afterward returned to the intensive care unit and was extubated in a stable condition. The postoperative angiogram demonstrated complete obliteration of the aneurysm without residual neck and patency of the right fetal PComA with severe stenosis at the origin. Due to concern for an intraluminal thrombus, aspirin was started the morning following surgery. The postoperative angiogram demonstrated impeded flow through the sylvian vein into the deep venous system (Fig. 2B). Routine postoperative laboratory studies were within normal limits. On the evening of postoperative day 1, the patient was found to be more somnolent and stopped following commands. Urgent head computed tomography (CT) demonstrated hemorrhage in the temporal lobe with surrounding edema (Fig. 4), raising concern for an infarct with hemorrhagic conversion. The patient was intubated, given platelets and a bolus of hypertonic saline, and then taken urgently to the operating room. The previous scalp incision was opened, and the prior craniotomy flap was removed. A contusion of the inferior temporal gyrus with extension through the pia mater was observed. The clot was evacuated, and friable, necrotic tissue was encountered. The bone was replaced, and the craniotomy was closed in a normal fashion.

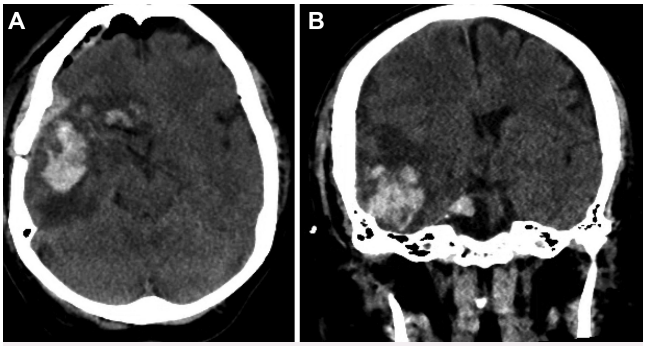

FIG. 4. Postoperative axial (**A**) and coronal (**B**) head CT demonstrate hemorrhage in the right temporal lobe with surrounding edema.

On the day following repeat craniotomy, the patient was extubated. On examination, she followed commands, had intact vision and speech, demonstrated no change in the Neurological Pupil Index of the right eye from preoperative readings, and showed at least antigravity in all extremities, with slight diffuse weakness in the left upper extremity. The patient underwent repeat head CT, which showed stable findings. The patient's cranial nerve III palsy improved, her left-sided weakness resolved, she was cleared by physical and occupational therapy, her diet was advanced, and she was discharged to an acute rehabilitation unit 12 days following admission (postoperative day 9). At her 2-week follow-up visit, the patient was doing well with improved ptosis, intact vision and speech, and a well-healed incision site.

Literature Review

A literature search was performed to identify published cases relevant to this report. The PubMed database was queried according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines using the following search terms alone and in combination: "cerebral," "venous," "thrombosis," "infarct," "hemostat," "hemostatic," "adhesive," "liquid," "flowable," "operation," "surgery," "craniotomy," and "craniectomy." English-language articles reporting cases of cerebral thrombosis after intraoperative use of flowable hemostatic agents were included. Articles classified as reviews, systematic reviews, meta-analyses, or animal studies were excluded. Studies lacking individual patient data or involvement of surgery, use of liquid adhesives, cerebral thrombosis, or intracranial infarct or hemorrhage were excluded.

A total of fifty-nine English-language, nonreview articles were identified. Of these, three articles met the inclusion criteria, with a total of eight patients. The mean patient age was 49 years, and the mean follow-up period was 17 months (Table 1). Five (62.5%) patients underwent retrosigmoid craniotomy, two (25.0%) underwent cervical spinal fusion, and one (12.5%) underwent suboccipital craniotomy. Five (62.5%) cases utilized a Surgifoam/thrombin mixture for hemostasis, two (25.0%) used Gelfoam, and one (12.5%) utilized Floseal with thrombin. In two (25.0%) cases, venous thrombosis was identified intraoperatively, and dural venous sinus injury was identified in five (62.5%) cases. The most common sites of thrombosis included the transverse and sigmoid sinuses (75.0%) and vertebral and/or basilar artery (25.0%).

Informed Consent

The necessary informed consent was obtained in this study.

Discussion

Intravascular injection of fibrin adhesive can result in local vascular occlusion, thromboembolism resulting in intracranial infarction or pulmonary embolism, or granulomatous inflammatory reactions.[5,6] We present a unique case of thrombosis of the sylvian vein secondary to intravascular injection of liquid fibrin adhesive at the skull base with retrograde thrombosis and subsequent venous congestion, cerebral edema, and ICH.

During extradural anterior skull base dissection, care must be taken to avoid insult to the drainage pathways of the sylvian vasculature. Unsurprisingly, integrity or occlusion of the cerebral veins has been shown to be among the most predictive factors of prognosis after the surgical management of intracranial aneurysm.[7–9] The SMCV, or superficial sylvian vein, typically runs anteriorly and caudally along the sylvian fissure and curves medially around the temporal tip. However, there is significant variation in the size of the SMCV and its drainage patterns.[8,9] The vein most commonly drains into the sphenoparietal sinus, with less common drainage into the sphenoidal emissary veins or into the anterior cavernous sinus, among others.[8,9] Due to changes in pressure gradients after vessel injury, along with the extensive drainage system of the SMCV, it is possible for a thrombus to travel retrogradely through the superior sylvian vein and occlude the superficial cerebral veins. Cerebral venous thrombosis causes outflow obstruction and subsequent retrograde pressure elevation within the venous system, which can in turn raise intracranial pressure (ICP). Elevated ICP can result in an increase in local capillary hydrostatic pressure and migration of erythrocytes through capillaries. Thus, cerebral venous thrombosis poses a high risk for spontaneous hemorrhage.[10] Because of the visualization of the white vein on the dural opening during the initial craniotomy and the identified location of the thrombus in the sylvian vein drainage with hemorrhage of the inferior temporal gyrus, retrograde thrombosis of flowable sealant is the most likely explanation for the venous thrombosis and hemorrhagic infarction in our case.

Singleton et al. found that iatrogenic vascular occlusions induced by the use of a liquid hemostatic matrix during cranial operations most commonly occur with an open, infratentorial approach and involvement of the transverse or sigmoid sinuses.[1] CT is the most sensitive imaging study to visualize vascular occlusion with a hemostatic agent.[1] Cerebral venous sinus thrombosis can be identified on CT without contrast as an intravascular hyperdensity.[1,11] Patients may not demonstrate acute signs of vascular occlusion,[1,12,13] which highlights the need for postoperative imaging and attention to any sudden changes in patient examination in cases of intraoperative use of flowable sealants. When operating near large cerebral veins or in the setting of known insult of the cerebral venous sinuses, hemostasis should be obtained primarily through the use of noninjectable hemostatic agents and pressure held to tamponade, with the judicious use of liquid adhesive agents.

Observations

We report a novel case of suspected intravascular administration of flowable adhesive resulting in superficial sylvian vein thrombosis with retrograde embolization and subsequent hemorrhagic infarction. In a literature review, eight prior cases of intracranial infarction or hemorrhage secondary to thrombosis with intravascular liquid adhesive were identified. The most common sites of thrombosis were the transverse and sigmoid sinuses for craniotomy approaches, followed by the vertebral and/or basilar arteries in patients undergoing cervical fusion.

TABLE 1. Literature review of patients with cerebral thrombosis following the intraoperative use of a flowable hemostatic agent

Authors & Year	Age (yrs)	Sex	Dx	Approach	Hemostat	Identified Intraop	Sinus Injury	Acute Postop Sx	Postop Imaging Indication	Hemostat Location	Sites of Thrombosis	Complications	FU Period (mos)
Singleton et al., 2011[1]	55	F	Rt cerebellar breast cancer metastasis	Retrosigmoid	Surgifoam/ thrombin	Yes	Yes	No	Intraop recognition	TS, SS	TS, SS	Postradiation CSF leak & meningitis	6
	33	M	Recurrent cerebellar hemangioblastoma (VHL)	Suboccipital	Surgifoam/ thrombin	Yes	Yes	No	Intraop recognition	TS, T	TS, SS, StS, T, SagS	None	18
	75	F	Lt hemifacial spasm	Retrosigmoid	Surgifoam/ thrombin	No	Yes	No	Cranial nerve injury	TSJ, SS	TS, SS	Cerebellar hemispheric infarction	21
	29	F	Rt glossopharyngeal neuralgia	Retrosigmoid	Surgifoam/ thrombin	No	No	HA	Postop HA	TSJ, SS	TS, SS	None	13
	40	F	Rt trigeminal neuralgia	Retrosigmoid	Surgifoam/ thrombin	No	Yes	No	Cranial nerve injury, 2.5 L op blood loss	TSJ, SS	TS, SS	Cerebellar hemispheric infarction	31
Coss et al., 2021[5]	44	M	Biopsy of cervical mass	Occipitocervical fusion (C3)	Gelfoam/ thrombin	No	No	No	POD3 AMS & sinus bradycardia	VA	VA	Infarcts of lat medulla & CMJ; death POD3	NA (death on POD3)
	63	F	DDD, cervical radiculopathy, & weakness	Ant cervical discectomy, bilat foraminotomies, C3–6 fusion	Floseal, thrombin foam pledgets	No	No	Delayed wakening, no spontaneous breathing	Delayed wakening from anesthesia	VA	V4 & basilar artery	Infarcts of pons, cerebellar hemisphere, vermis, frontal lobe; embolization of distal brachial artery; death POD1	NA (death on POD1)
Turel & Turel, 2023[12]	52	M	Lt tentorial meningioma	Retrosigmoid	Surgicel & Gelfoam	No	Yes	No	POD2 HA, N/V, AMS, bradycardia	Not reported	TS	Hemorrhagic infarct cerebellar hemisphere & brainstem, compression of 4th ventricle, & obstructive hydrocephalus	48

AMS = altered mental status; ant = anterior; CMJ = cervicomedullary junction; CSF = cerebrospinal fluid; DDD = degenerative disc disease; Dx = diagnosis; FU = follow-up; HA = headache; NA = not applicable; N/V = nausea and vomiting; POD = postoperative day; SagS = sagittal sinus; SS = sigmoid sinus; StS = straight sinus; Sx = symptom; T = torcula; TS = transverse sinus; TSJ = transverse-sigmoid junction; V4 = fourth segment of vertebral artery; VA = vertebral artery; VHL = von Hippel–Lindau syndrome.

Lessons

Retrograde embolization of a cerebral vein can occur after intravascular injection of flowable liquid hemostatic agents during craniotomy or surgical fusion. The surgical approach, nearby vasculature, anatomical variations, options for hemostasis, and potential complications of liquid adhesive use are critical considerations in the management of neurosurgical patients.

References

1. Singleton RH, Jankowitz BT, Wecht DA, Gardner PA. Iatrogenic cerebral venous sinus occlusion with flowable topical hemostatic matrix. *J Neurosurg*. 2011;115(3):576-583.
2. Allotey JK, King AH, Kumins NH, et al. Systematic review of hemostatic agents used in vascular surgery. *J Vasc Surg*. 2021;73(6): 2189-2197.
3. Chiara O, Cimbanassi S, Bellanova G, et al. A systematic review on the use of topical hemostats in trauma and emergency surgery. *BMC Surg*. 2018;18(1):68.
4. Fischer CP, Wood CG, Shen J, et al. A randomized trial of aprotinin-free fibrin sealant versus absorbable hemostat. *Clin Appl Thromb Hemost*. 2011;17(6):572-577.
5. Coss DJ, Tlomak W, Cochran E. Two cases of cerebral infarcts caused by topical hemostatic agent embolism. *Am J Forensic Med Pathol*. 2021;42(2):182-185.
6. Montemurro N, Murrone D, Romanelli B, Ierardi A. Postoperative textiloma mimicking intracranial rebleeding in a patient with spontaneous hemorrhage: case report and review of the literature. *Case Rep Neurol*. 2020;12(1):7-12.
7. Kageyama Y, Fukuda K, Kobayashi S, et al. Cerebral vein disorders and postoperative brain damage associated with the pterional approach in aneurysm surgery. *Neurol Med Chir (Tokyo)*. 1992; 32(10):733-738.
8. Dean BL, Wallace RC, Zabramski JM, Pitt AM, Bird CR, Spetzler RF. Incidence of superficial sylvian vein compromise and postoperative effects on CT imaging after surgical clipping of middle cerebral artery aneurysms. *AJNR Am J Neuroradiol*. 2005; 26(8):2019-2026.
9. Mason A, Barrow DL. Anterior circulation aneurysms. In: Ellenbogen R, Sekhar LN, Kitchen ND, Brito da Silva H, eds. *Principles of Neurological Surgery*. 4th ed. Elsevier; 2018:268-270.
10. Billinghurst L, Moharir M. Sinovenous thrombosis in infants and children. In: Swaiman KF, Ashwal S, Ferriero DM, et al, eds. *Swaiman's Pediatric Neurology*. 6th ed. Elsevier; 2017:858-864.
11. Osborn AG. *Diagnostic Neuroradiology*. Mosby; 1994.
12. Turel KE, Turel MK. Catastrophic outcome following apparently trivial nondominant transverse sinus injury during resection of a tentorial meningioma: case report. *Acta Neurochir Suppl*. 2023;130: 41-45.
13. Gazzeri R, Galarza M, Conti C, De Bonis C. Incidence of thromboembolic events after use of gelatin-thrombin-based hemostatic matrix during intracranial tumor surgery. *Neurosurg Rev*. 2018; 41(1):303-310.

Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Davies, Lockwood, Hsu. Acquisition of data: Hovis, Davies. Analysis and interpretation of data: Davies. Drafting the article: Hovis, Lockwood. Critically revising the article: Hovis, Davies, Lockwood. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Hovis. Administrative/technical/material support: Lockwood. Study supervision: Hovis, Lockwood, Hsu.

Correspondence

Gabrielle E. A. Hovis: University of California, Irvine, Orange, CA. ghovis@hs.uci.edu.