



Low rate of complications and subsequent surgery following MMA microparticles embolization in high-risk cSDH patients with early antiplatelet/anticoagulant reintroduction

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Purpose or Learning Objective:

With aging population and increasing antiplatelet and anticoagulant regiment, chronic subdural hematoma (cSDH) is an increasingly common pathology that may even become the most common neurosurgical condition by 2030 according to some projections[1]. cSDH is classically explained by traction rupture of bridging veins, but we previously hypothesized that the pivotal structure of cSDH could be the dural vascular plexus (DVP) instead[2]. Consisting of a rich capillary network located within the dural border cell layer, the DVP is fed by branches of the middle meningeal artery (MMA) and drains directly into the dural venous sinus apart from bridging vein. This theory might better account for dural arterio-venous fistula (dAVF)-associated SDH (also described in Cognard type 1/2 dAVF where there is no bridging/cortical vein involvement) and efficiency of MMA embolization (MMAE) while not contradicting the traction rupture (but concerning the DVP and not the bridging veins) physiopathology of post-traumatic SDH.

Spontaneous course of cSDHs is difficult to foresee and there is no definite guideline for their optimal management. Surgical management (burr hole craniostomy or craniotomy) might be required for large and symptomatic collections whereas conservative management is preferred for smaller pauci- or a-symptomatic collections but recurrent/progressing hemorrhages are frequent in both situations[3]. Unfavorable course are mainly reported ranging from 5 to 30%[3-5]. Accurate estimations are polluted by variable outcomes measures in the literature[3] and the lack of clear and consistent definition of recurrence in recent large trials[6].

MMAE in the management of chronic subdural hematoma has been an exciting trending topic in our field for the last few years. Since the first report in 2000[7], several recent trials explored the efficiency and safety of this procedure in large cohorts. On the one hand, EMBOLISE[8], MAGIC-MT[9] and STEM[10] trials reported favourable endpoints in the MMAE with liquid embolic agents groups as compared to standard management. On the other hand, EMPROTECT[11] used microparticles as embolization agent but did not lead to a significant gain compared to standard medical care alone.

Despite growing data and experience from neuro-interventionists worldwide, some crucial questions remain to answer. First, the exact place of MMAE remains to be unraveled but growing evidence points at the efficiency and safety of this procedure aiming to modify pressure regimen within the dural vascular plexus and thus favoring subdural collection resorption. Second, the most efficient technique is still uncertain with recent data favouring liquid embolic agents over microparticles.

So far, we limited MMAE to patients at high risk of pejorative evolution or recurrence, in addition to surgery if significantly symptomatic, or to recurring subdural collection.

Methods or Background:

From November 2021 to December 2025, we performed 81 MMAE in 70 patients in one tertiary center. Considering loss for follow-up and unrelated death, we included 75 MMAE in 65 patients (sex ratio 2,1 - median age 73 years). These patients were deemed at high risk due to single (29,2%) or double antiplatelet therapy (23,1%), anticoagulant therapy (23,1%), constitutional or acquired coagulopathy (4,6%). Symptomatic recurrent SDH (13,8%) were also considered for embolization even in absence of previously detailed features. Moreover, 18,5% of patients had more than one risk factor.

Age (median +/- MAD)	73 ± 7 (mode = 72)
Sex ratio M/F	2,1
Ethylism	18 (26,2%)
Risk factors by patients (n=65)	
Coagulopathy	3 (4,6%)
Anticoagulant	15 (23,1%)
Single anti-platelet therapy	19 (29,2%)
Dual anti-platelet therapy	7 (10,8%)
SDH recurrence	9 (13,8%)
Multiple risk factors	12 (18,5%)
Risk factors by cSDH (n=75)	
Coagulopathy	4 (5,3%)
Anticoagulant	17 (22,7%)
Single anti-platelet therapy	24 (32%)
Dual anti-platelet therapy	8 (10,7%)
SDH recurrence	10 (13,3%)
Multiple risk factors	12 (16%)

Table 1: Registry descriptive statistics.

Procedures were preferentially performed under general anesthesia (75,5%) and femoral approach (98,5%). MMA coiling was performed in 72% of cases of microparticles embolization (96% of procedures as liquid embolic agents were used in 4%). MMAE was performed in association with surgical management in 50% of cases with a median of two days prior to endovascular procedure.

Femoral access	64 (98,5%)
General anesthesia	49 (75,4%)
Length of procedure (minutes)	55 ± 14 (mode 55)
Dose (Gy.cm2)	89,5 ± 30,7 (mode 89)
Embolization	
Liquid embolic agents	3 (4%)
Microparticles	72 (96%)
alone	18 (24%)
+ coil(s)	54 (72%)
Treatment reintroduction (60 cSDH)	
Unnecessary treatment	5 (8,3%)
No discontinuation	14 (23,3%)
Reintroduction	41 (68,3%)
Time to reintroduction (days)	2 ± 2 (mode 2)

Table 2: Intervention and peri-procedural care descriptive statistics.

Results or Findings:

MMAE, alone or in association with surgical management when required, allowed early and safe reintroduction of necessary antiplatelet and/or anticoagulant therapy. Antiplatelet/anticoagulant therapy wasn't discontinued in 23,3% of cases. If discontinued, it was re-introduced between day -3 and day 46 (median and mode at day 2). Note that any treatment was definitively withheld in 8,3% of cases.

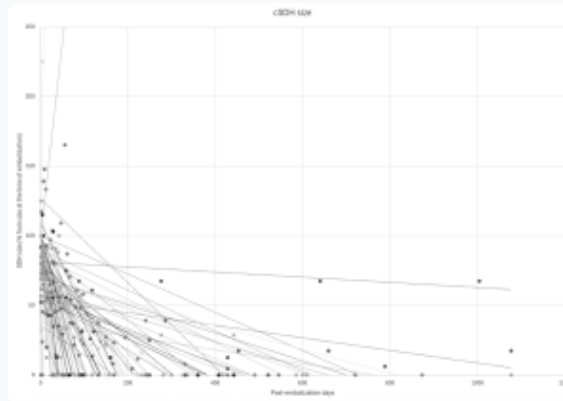


Fig 1: Evolution of cSDH size (CT scanner acquisitions, all measures in coronal reconstructions) after MMAE (t0). Post embolization time expressed in days.

Resorption of cSDH following MMAE occurred in most cases. A complete resorption of the cSDH was acquired in 57,3% as only one patient progressed from day one. Significant resorption (>50% decrease of the collection size in the coronal plane on CT scan) was reached in 6,7% of patient at day 30, 44% at day 90, 64% at day 180 and 84% over 180 days. When transient progression occurred it was mainly observed early (9,6% of patients at day 30). There was otherwise no recurrence.

Maximal resorption		
Complete	43 (57,3%)	
51-99%	20 (26,7%)	
1-50%	11 (14,7%)	
0%/progression	1 (1,3%)	
> 50% resorption rate		
At 30 days	6,7%	
At 90 days	44%	
At 180 days	64%	
At 180+ days	84%	
Transient progression rates		
At 30 days	9,6%	
At 90 days	1,8%	
At 180 days	1,8%	
At 180+ days	0%	
Reccurence rates		
At 30 days	0%	
At 90 days	0%	
At 180 days	0%	
At 180+ days	0%	

Table 3: cSDH resorptions rates.

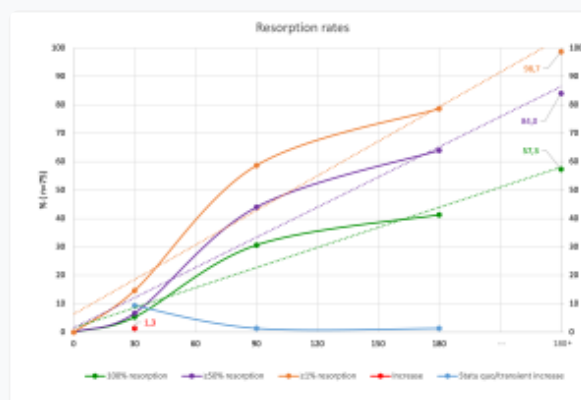


Fig 2: Timing of cSDH resorption for different thresholds (>1%, >50% and complete resorption). Increase and statu quo/transient increased ase reported with corresponding time point. Final resorption rates are reported at >180 days. Dotted line express linear tendency. Post embolization time expressed in days.

Different risk factors led to different timely resorption rates, with coagulopathy alone and recurrence alone leading to 50% and 70% of >50% resorption over 180 days, respectively. Nonetheless, resorption rates in the patients with coagulopathy alone or associated to other risk factor(s) were not significantly different compared to other groups at all time points.

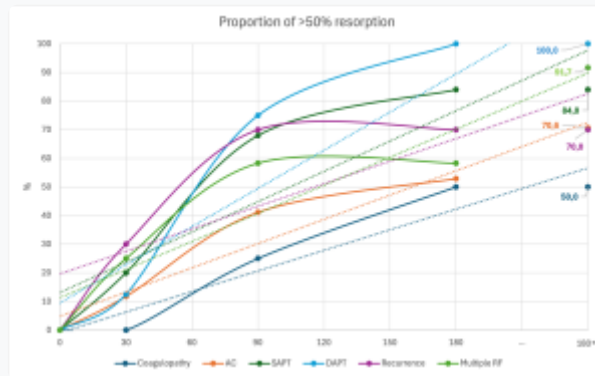


Fig 3: Timing of cSDH resorption for the different sub-groups of risk factors. Final resorption rates are reported at >180 days. Dotted line express linear tendency. Post embolization time expressed in days.

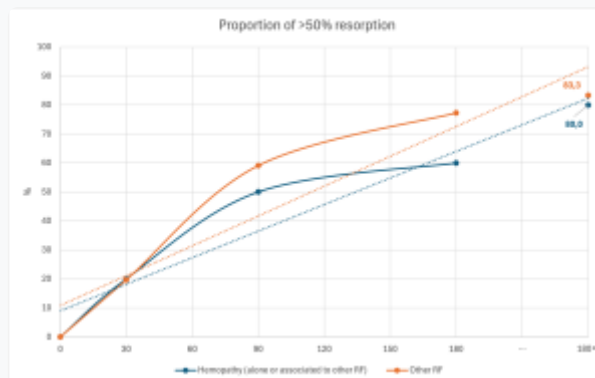


Fig 4: Timing of cSDH resorption comparing coagulopathy alone or associated with other risk factor(s) and other risk factors. Final resorption rates are reported at >180 days. Dotted line express linear tendency. Post embolization time expressed in days. Note no statistical difference at all time points ($p = .794 - .957$).

There was no difference in resorption rate between MMAE alone or associated with surgery.

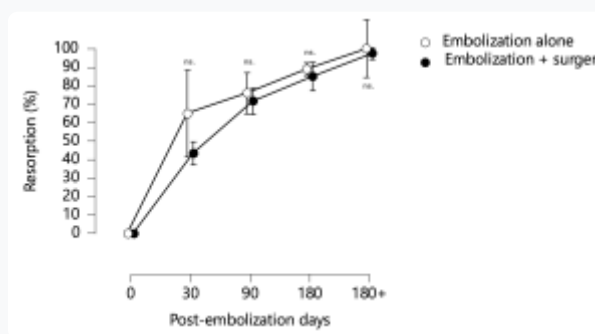


Fig 5: Extent of resorption at 30, 90, 180 and >180 days in MMAE alone and MMAE associated with surgery. Note that dots are slightly shifted to improve readability.

MMAE, even in this high-risk population, has a low yield of complications. We observed 2 angiographic complications (transient duro-dural fistula) and 3 transient clinical complications:

- two patients (3,1%) suffered from ipsilateral headaches that were efficiently controlled by WHO step 1/2 analgesics ;
- one patient (1,5%) presented late-onset (48h after the procedure) CN VI palsy. Clinical evolution was favorable under tapered corticosteroids regiment.

Unfavourable outcomes occurred in 5 patients (6,7%). Only 2 cSDH (2,7%) required subsequent surgery and 3 patients (4%) experienced unfavourable clinical course leading to death.

Coagulopathy alone or associated to other risk factor(s) was associated with unfavourable outcomes ($p= .0015$).

Complications	5 (7,7%)
Transient ipsilateral headaches	2 (3,1%)
Transient CN VI palsy	1 (1,5%)
Iatrogenic duro-dural fistula	2 (3,1%)
Unfavorable outcomes	5 (6,7%)
Letal clinical course	3 (4%)
Need for (re-)surgery	2 (2,7%)
Coagulopathy vs other risk factors	$\chi^2 (1, N = 75) = 10.10, p^{**} = .0015$

Table 4: MMAE complications and unfavourable outcomes.

Conclusion:

Besides intrinsic limitations due to prospective registry design, MMAE using microparticles seems to be a safe and effective procedure in high-risk patients, alone or associated with surgery if deemed necessary after pluridisciplinary concertation. No definitive, clinically relevant complication of the procedure was noted. Subsequent surgery was required in only 2,7% of cases. Unfavourable outcomes might be lower than what is classically reported in the litterature for classic management of cSDH. Coagulopathy alone or associated with other risk factors might be associated with poorer outcomes but not significantly poorer resorption rates. These patients might be less suitable for MMAE compared to other risk groups and physicians might have to take this into account when making clinical decisions.

Personal Information:

References:

- Balser D, Farooq S, Mehmood T, Reyes M, Samadani U. Actual and projected incidence rates for chronic subdural hematomas in United States Veterans Administration and civilian populations. *J Neurosurg.* 2015;123(5):1209-1215. doi:10.3171/2014.9.JNS141550
- Lebeau J, Moïse M, Bonnet P, Martin DH, Otto B, Scholtes F. The dural vascular plexus in subdural hematoma: Illustration through a case of dural arteriovenous fistula. *Surg Neurol Int.* 2022;13:212. doi:10.25259/sni_333_2022
- Mehta V, Harward SC, Sankey EW, Nayar G, Codd PJ. Evidence based diagnosis and management of chronic subdural hematoma: A review of the literature. *Journal of Clinical Neuroscience.* 2018;50:7-15. doi:10.1016/J.JOCN.2018.01.050/ASSET/AFFC90F7-42F0-4E47-AC32-052D934BBD98/MAIN.ASSETS/GR1.SML
- Jeong S II, Kim SO, Won YS, Kwon YJ, Choi CS. Clinical Analysis of Risk Factors for Recurrence in Patients with Chronic Subdural Hematoma Undergoing Burr Hole Trephination. *Korean J Neurotrauma.* 2014;10(1):15. doi:10.13004/KJNT.2014.10.1.15
- Cofano F, Pesce A, Vercelli G, et al. Risk of Recurrence of Chronic Subdural Hematomas After Surgery: A Multicenter Observational Cohort Study. *Front Neurol.* 2020;11:560269. doi:10.3389/FNEUR.2020.560269
- Madsbu MA, Gulati S. Middle Meningeal Artery Embolization for Subdural Hematoma. *New England Journal of Medicine.* 2025;392(11):1143-1144. doi:10.1056/NEJMC2416123
- Mandai S, Sakurai M, Matsumoto Y. Middle meningeal artery embolization for refractory chronic subdural hematoma. Case report. *J Neurosurg.* 2000;93(4):686-688. doi:10.3171/JNS.2000.93.4.0686
- Davies JM, Knopman J, Mokin M, et al. Adjunctive Middle Meningeal Artery Embolization for Subdural Hematoma. *New England Journal of Medicine.* 2024;391(20):1890-1900. doi:10.1056/nejmoa2313472
- Liu J, Ni W, Zuo Q, et al. Middle Meningeal Artery Embolization for Nonacute Subdural Hematoma. *New England Journal of Medicine.* 2024;391(20):1901-1912. doi:10.1056/nejmoa2401201
- Fiorella D, Monteith SJ, Hanel R, et al. Embolization of the Middle Meningeal Artery for Chronic Subdural Hematoma. *New England Journal of Medicine.* 2025;392(9):855-864. doi:10.1056/nejmoa2409845
- Shotar E, Mathon B, Salle H, et al. Meningeal Embolization for Preventing Chronic Subdural Hematoma Recurrence After Surgery: The EMPROTECT Randomized Clinical Trial. *JAMA.* 2025;334(2):127-135. doi:10.1001/jama.2025.7583

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Sex ratio M/F	2
Thrombocytopenia	18 (26,2)
Risk factors by patients (n=65)	
Coagulopathy	3 (4,6)
Anticoagulant	15 (23,1)
Single anti-platelet therapy	19 (29,2)
Dual anti-platelet therapy	7 (10,8)
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Table 1: Registry descriptive statistics.

Transient ipsilateral headaches
Transient CN VI palsy
Genetic duro-dural fistula
S
Letal clinical course
Need for (re-)surgery
MMAE vs other risk factors $X^2 (1, N)$

Table 4: MMAE complications and unfavourable outcomes.

Access	6
Anesthesia	4
Procedure (minutes)	55 ± 14 (range 20-120)
Time to reintroduction (days)	89,5 ± 30,7 (range 0-180)
Intervention	
Liquid embolic agents	
Microparticles	
alone	
+ coil(s)	
Reintroduction (60 cSDH)	
Unnecessary treatment	
No discontinuation	1
Reintroduction	4
Time to reintroduction (days)	2 ± 2

Table 2: Intervention and peri-procedural care descriptive statistics.

Maximal resorption	
Complete	43 (57,3%)
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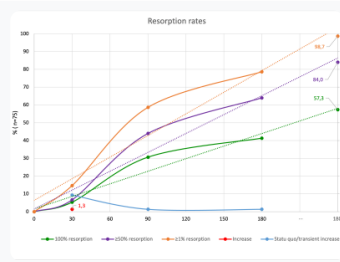


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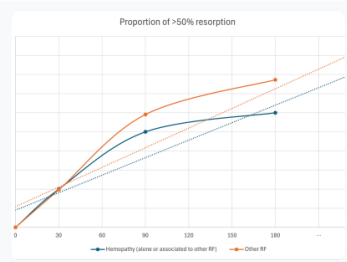


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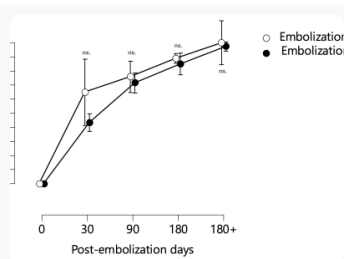


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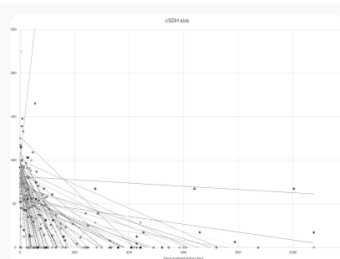


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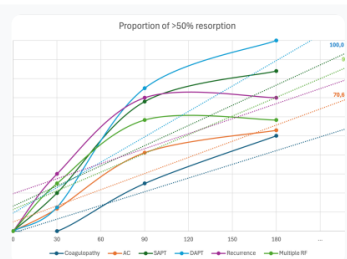


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