Middle meningeal artery embolisation for treatment of chronic subdural haematoma

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Introduction:

Traditional treatment options of chronic subdural haematoma (CSDH) include conservative treatment and surgical evacuation/ drainage. However, recurrence remains a major issue, which could be up to 20%[1]. There has been emerging level 1 evidence suggesting middle meningeal artery (MMA) embolisation as an effective and safe treatment option for CSDH. This study aims at sharing experience in our centre in the treatment of CSDH with MMA embolisation. We would also review current evidence in literature, discuss about the theory behind MMA embolisation and illustrate important branches/ dangerous anastomosis during embolisation.

Method:

We retrospectively review all the CSDH which were treated with middle meningeal artery embolisation in Queen Mary Hospital from 6/2022 to 6/2024.

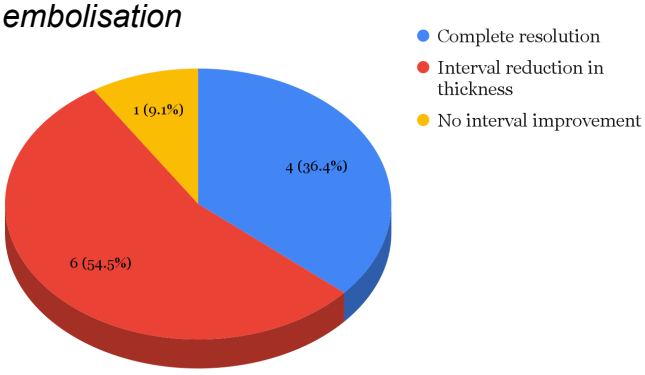
Results:

A total of 11 patients with CSDH were treated with middle meningeal artery embolisation from 6/2022 to 6/2024. Polyvinyl alcohol was used as embolic agent in all cases. After MMA embolisation, follow up CT brain was arranged in around 1 month.

Demography of patients

Gender	Male	10
	Female	1
Age	<60	4
	≥60	7
Distribution of CSDH	Unilateral	8
	Bilateral	3
Episodes of embolisation performed	1	10
	2	1

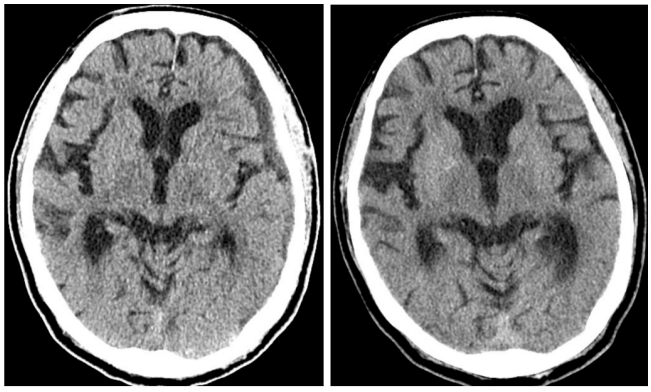
Changes of CSDH in CT 1 month after embolisation



>90% showing interval improvement/ resolution

All patients showed symptomatic improvement during follow up. For the one patient who did not show interval improvement in thickness of CSDH in follow up CT, he remained asymptomatic during follow up, and he would be under close clinical and radiological monitoring. Two patients received burr hole operation just before embolisation due to the significant mass effect of CSDH.

For complications, there was one patient who showed recurrent CSDH despite initial interval improvement in follow up CT 1 month after embolisation. In CT performed 2 months after embolisation, recurrent CSDH was noted with mild mass effect and required second embolisation. Subsequent follow up CT showed interval improvement in thickness of CSDH.



CT brains before (left) and 1 month after (right) embolisation, showing complete resolution of CSDH.

Discussion:

Effectiveness and safety of MMA embolisation:

Current experience in our centre showed MMA embolisation as an effective treatment option for CSDH, with 100% symptomatic improvement and >90% interval improvement/ resolution of CSDH in CT 1 month post embolisation. There was only 1 case of recurrent CSDH requiring second embolisation.

There are currently three randomised, prospective trials for MMA embolisation which are undergoing, namely EMBOLISE, MAGIC-MT and STEM.

The results of these trials were reported in International Stroke Conference 2024, which all showed promising results, with lower rates of recurrence or progression requiring surgical management in the group of MMA embolisation, and at least non-inferior results in terms of safety outcome.

EMBOLISE:

Primary outcome: rate of haematoma recurrence or progression requiring surgical drainage within 90 days of the treatment

- Embolisation plus surgery: 4.1%
- Surgery alone: 11.3%

(relative risk 0.36, 95% confidence interval (95% CI) 0.11 to 0.80, P=0.0081)[2,3]

For safety outcome, zero adverse events related to the Onyx™ device at 90 days is reported. The incidence of neurological deterioration based on modified Rankin Scale in the embolisation group is non-inferior to the control group (11.9% vs 9.8%, non-inferiority margin 12%, P=0.0022)[2,3].

MAGIC-MT:

Primary outcome: symptomatic recurrence or progression of the subdural haematoma or death within 90 days after randomisation

- Embolisation: 7.2%
- Control: 12.2%

(Odds ratio (OR) −4.93, 95% CI −9.37 to 0.63, P=0.02)[2,3].

For safety outcome, MAGIC-MT trial shows lower rates of serious adverse events in the embolisation group (6.7%) compared with usual care group (11.6%) (OR 0.54, 95% CI 0.32 to 0.92, P=0.02)[2,3]. All-cause death is 2.7% in the embolisation group and 3.1% in the control group, while major disabling stroke is 0% in the embolisation group and 0.6% in the control group[2,3].

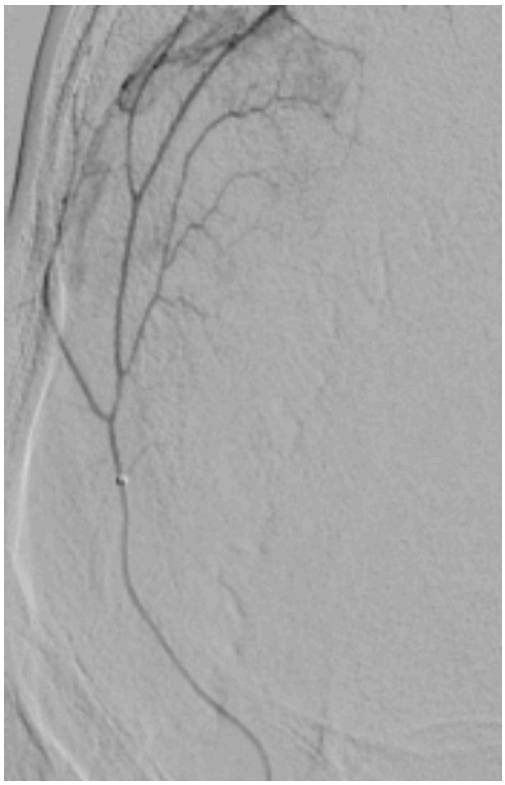
EMBOLISE: Embolisation of the Middle Meningeal Artery With Onyx Liquid Embolic System in the Treatment of Subacute and Chronic Subdural Haematoma.
MAGIC-MT: Managing Non-Acute Subdural Haematoma Using Liquid Materials: A Chinese Randomized Trial of Middle Meningeal Artery Treatment.
STEM: The Squid Trial for the Embolisation of the MMA for the treatment of cSDH.

STEM:
Primary outcome: the rates of residual or re-accumulation of the subdural haematoma requiring new intervention within 180 days of randomisation, any new, major disabling stroke, myocardial infarction or death of any cause within 180 days of randomisation

- Embolisation: 15.2%
- Control: 39.2%

(OR 3.60, 95% CI 1.92 to 6.78, P=0.0001)[2,3].

For safety outcome, all-cause death is 2.7% in the embolisation group and 3.1% in the control group, while major disabling stroke is 0% in the embolisation group and 0.6% in the control group[2,3].



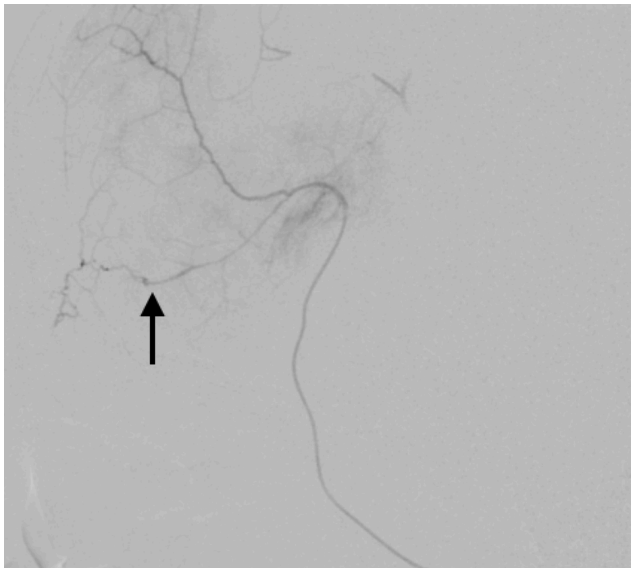
Digital subtraction angiography (DSA) showing cotton wool like staining of distal vasculature of MMA, corresponding to the theory of angiogenesis in the formation of CSDH.

<u>Theory behind MMA embolisation:</u>

MMA embolisation is effective in lowering rates of recurrence or progression of CSDH. Understanding the pathophysiology and theory behind would help explain the situation. There has been proposed theory that inflammation and angiogenesis play significant role in CSDH formation. Damage to dural border cells lead to inflammatory reaction. Then recruitment of inflammatory cells results in neomembrane formation, and the release of angiogenic factors promotes the formation of fragile capillaries within the neomembrane. Leakage of blood and fluid afterwards lead to sustained inflammation again, resulting in cycle and CSDH formation[4,5]. This could partly explain the elevated rates of recurrence after evacuation of CSDH. MMA embolisation thus targets the angiogenesis.

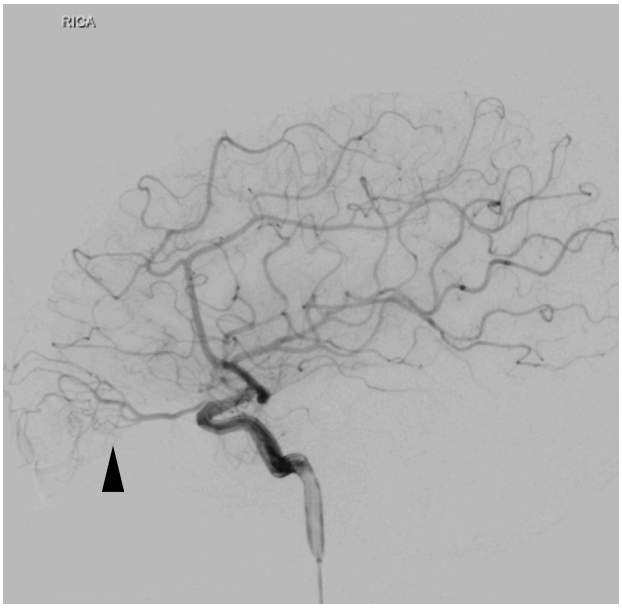
<u>Identifying important branches/ dangerous anastomosis during embolisation:</u>

There are potential risks for MMA embolisation, with particular emphasis on inadvertent embolisation. Identification of important branches/ dangerous anastomosis is essential during embolisation.

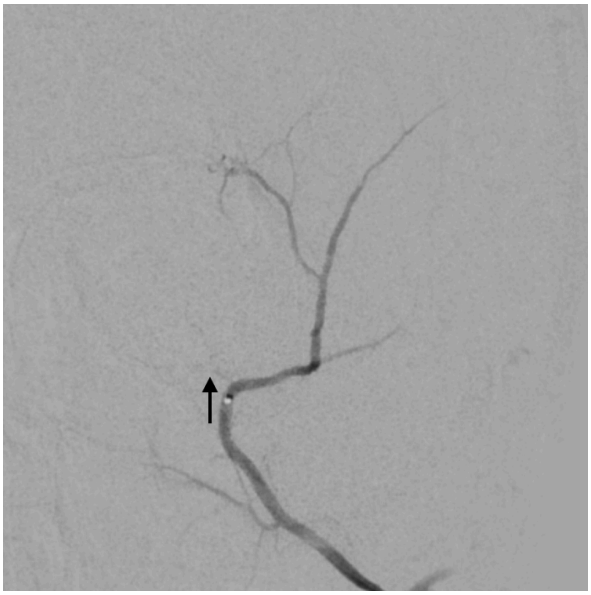


(a)

(c)



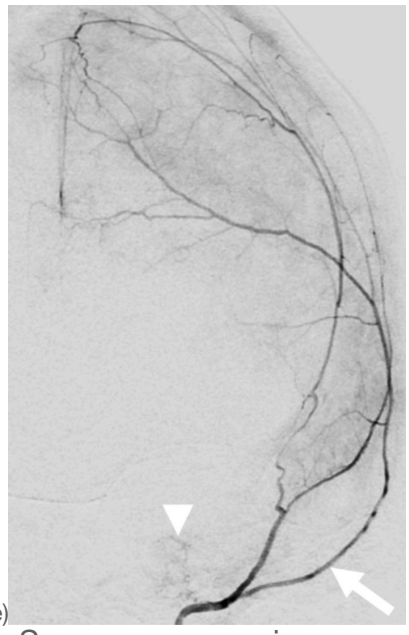
(b)



(d)

Middle meningeal artery angiogram (a) demonstrating <u>meningolacrimal branch</u> (arrow), with (b) corresponding internal carotid artery angiogram showing lacrimal arterial network as reference (arrowhead). Embolisation has to be distal to this branch. Otherwise, there is risk of reflux back to ophthalmic artery.

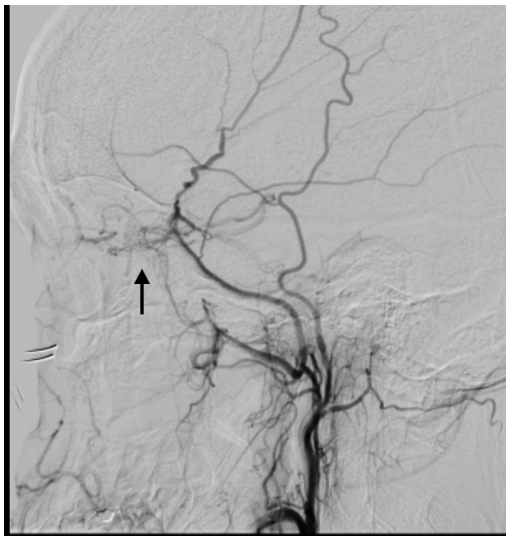
Middle meningeal artery angiograms (c) and (d) demonstrating <u>petrous branch</u> of middle meningeal artery (arrows). Embolisation has to be distal to this branch. Otherwise there is risk of facial nerve injury.



(e)

Source: neuroangio.org

Do not mix up petrous branch and petrosquamosal branch. Petrosquamosal branch always projects laterally on frontal view. (e) DSA showing petrosquamosal branch which projects laterally (arrow), versus petrous branch which projects slightly medially (arrowhead).



External carotid angiogram showing meningo-ophthalmic variant (arrow)

Conclusion:

MMA embolisation is an effective and safe treatment option for chronic subdural haematoma. A good understanding of neurovascular anatomy is important to avoid potential complication during embolisation.

References:

1. El Rahal A, Beck J, Ahlborn P, *et al*. Incidence, therapy, and outcome in the management of chronic subdural haematoma in Switzerland: a population-based multicenter cohort study. *Front Neurol*. 2023; 14: 1206996
2. Joseph R. Geraghty, Fernando D. Testai. Advances in neurovascular research: Scientific highlights from the 2024 international stroke conference. *Journal of Stroke and Cerebrovascular Diseases.* Volume 33, Issue 5, 107671, May 2024
3. Michael R Levitt, Joshua A Hirsch, Michael Chen. Middle meningeal artery embolisation for chronic subdural haematoma: an effective treatment with a bright future. *J NeuroIntervent Surg* Month 2024 Vol 0
4. Edlmann, E., Giorgi-Coll, S., Whitfield, P.C et al. Pathophysiology of chronic subdural haematoma: inflammation, angiogenesis and implications for pharmacotherapy. *J Neuroinflammation.* 2017; 14:108
5. Ralf Weigel, Lothar Schilling, Joachim K Krauss. The pathophysiology of chronic subdural haematoma revisited: emphasis on aging processes as key factor. *GeroScience*. 2022 Apr 23;44(3):1353–1371.