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Occult middle meningeal artery to middle cerebral artery anastomosis associated with prior trauma

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SUMMARY

The report describes a patient who presented with traumatic right temporoparietal calvarial fracture with chronic right subdural haematoma who underwent right middle meningeal artery embolisation with n-BCA during which direct filling of an anterior temporal branch of the middle cerebral artery was observed.

BACKGROUND

Chronic subdural haematoma (cSDH) is one of the most common diagnoses in neurosurgery with increasing incidence in the ageing population.[1] Medical management of patients who do not require emergent surgical evacuation includes observation, statins, steroids, tranexamic acid and surgical approaches to cSDH including craniotomy, burr holes and subdural evacuating port systems. Despite how common cSDH is, there exist no consistent evidence-based guidelines or indications for which type of intervention patients should undergo. While surgical approaches are effective in relieving the mass effect of subdural blood, it does not address the underlying pathophysiological mechanisms (ie, bleeding from the outer membrane of dura mater) thought to underly subdural haematoma formation, and recurrence is common.[2]

Middle meningeal artery (MMA) embolisation has emerged as a promising treatment strategy for patients with cSDH, by addressing the inflow to the dural membranes via the meningeal arteries. Ban *et al* report a treatment failure rate of 2.2% in symptomatic patients with cSDH treated with MMA embolisation, compared with a 27.5% of failure rate derived from a large historical control group (comprised of 469 patients) who were managed with conventional medical and surgical interventions.[2] To date, only one randomised controlled trial evaluating MMA embolisation for cSDH compared with conservative management has been published.[3] In this study, Lam *et al* included 36 patients who required surgical evacuation of subdural haematoma, 19 of which underwent subsequent MMA embolisation. While functional outcomes in the embolisation group were improved compared with control group, the study failed to meet the primary outcome of improved symptomatic recurrence requiring re-do surgical evacuation given the small sample size, with three patients in the control arm requiring repeat surgery, and no patients who underwent MMA embolisation requiring repeat surgery.

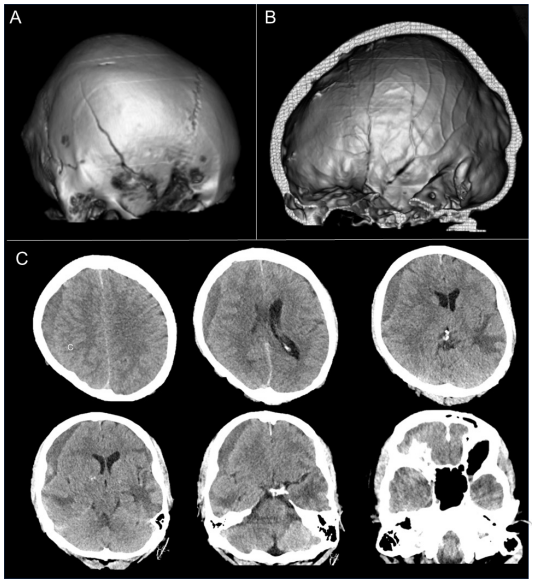

Figure 1 3D reconstruction of temporoparietal bone fracture (A). Sagittal 3D reconstruction of inner skull surface showing fracture through the parietal branch of MMA (B). Axial images of chronic right-sided subdural haematoma (C). MMA, middle meningeal artery. 3D, three dimensions.

Notably, the choice of embolic material for MMA embolisation widely varies, and studies evaluating polyvinyl alcohol particles, ethylene-vinyl alcohol dissolved in dimethyl-sulfoxide (Onyx; Medtronic Neurovascular, Irvine, California, USA), ethylene vinyl alcohol copolymer with suspended micronised tantalum dissolved in dimethyl sulfoxide (Squid; Balt, Montmorency, France), PHIL liquid embolic (MicroVention, Aliso Viejo, California, USA), n-butyl cyanoacrylate (n-BCA) and endovascular coils with and without gelatin sponge, have all been described in the literature.[4] Meta-analysis comparing the choice of embolic for MMA embolisation has insufficient available data to reach a conclusion regarding efficacy differences between the agents.[5]

Regardless of embolic choice, identification of extracranial to intracranial anastomoses prior to MMA embolisation is paramount to performing a safe procedure.[6] Persistent connections between extracranial and intracranial circulation are relatively common and are broadly categorised into orbital, petrocavernous and upper cervical connections. Identification of persistent connections allows for avoidance of embolic stroke and cranial nerve palsies. Additionally, it

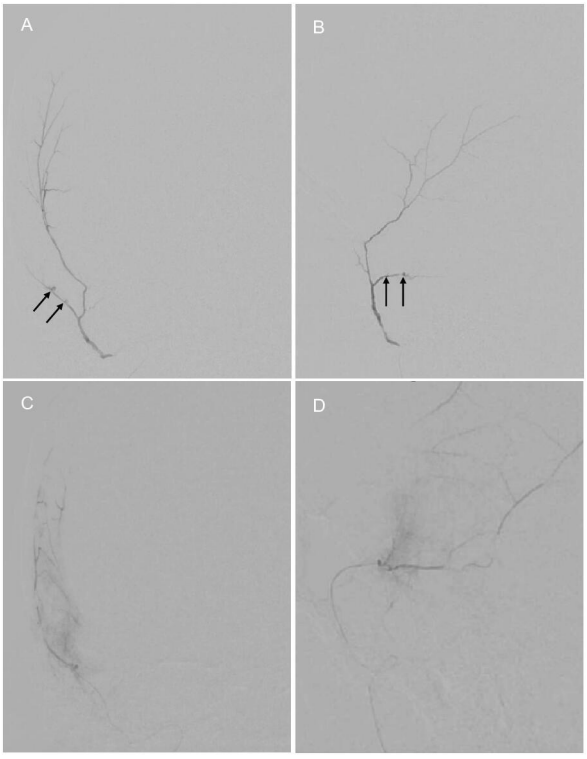

Figure 2 Microcatheter injection from middle meningeal artery (A, B) and superselective injection from parietal branch (C, D). Two pseudoaneurysms arise from the parietal branch (arrows).

has been shown that head trauma can result in MMA pseudoaneurysms[7] and dural arteriovenous fistulas[8 9] which require special attention to avoid complications during MMA embolisation. However, to our knowledge, head injury resulting in direct meningeal to pial anastomosis of the MMA to middle cerebral artery (MCA) has never been described in the literature.

CASE PRESENTATION

This patient is in his 60s with no known medical history and presented to an outside hospital following an unwitnessed fall. On arrival, the patient was confused, though responsive and following commands and without focal neurological deficit (Glascow Coma Score of 14). Initial head CT was significant for acute bilateral, right greater than left, subdural haematomas, scattered subarachnoid haemorrhage and right temporoparietal bone fracture along the groove for the posterior division of the MMA with adjacent haemorrhagic contusion. Subsequent head CT 24 hours after admission was stable and the patient was managed conservatively, with discharge to rehabilitation at our facility. Head CT was obtained on post-fall day 19 while in rehabilitation that showed expansion of the right-sided subdural haematoma with mixed density blood products (15 mm from 6 mm, figure 1). The repeat head CT was performed to assess haematoma resolution/reaccumulation and guide management as is standard at our institution, and not secondary to any decline in neurological status. At the time of repeat head CT, the patient demonstrated decreased executive functioning, slowed processing speed with Orientation Log score of 24/30. Family members also noted improved cognition compared with day of presentation during his stay in rehabilitation, but was noted not to be back at this baseline at the time of repeat imaging.

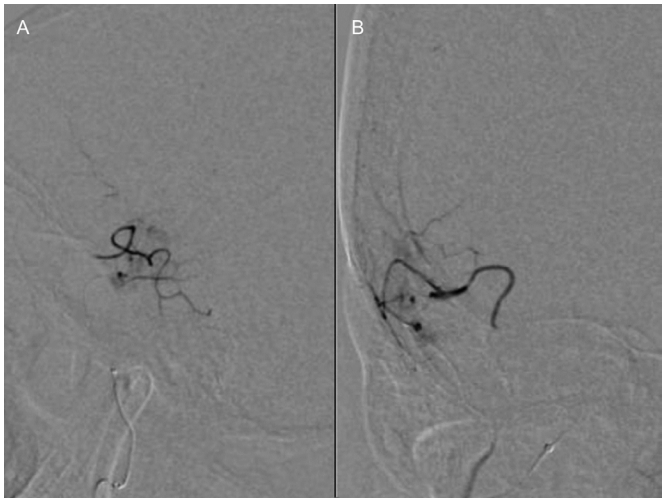

Figure 3 25% n-BCA glue injection into parietal branch of the middle meningeal artery; anterior–posterior projection (left panel) lateral projection (right panel). Initially glue is seen filling the proximal aspect of the MMA and the pseudoaneurysms, with subsequent direct filling of an anterior temporal branch of the middle cerebral with glue coursing medially. Injection was immediately stopped with a total of 0.4 cc of glue instilled (online supplemental video). MMA, middle meningeal artery; n-BCA, 25% N-butyl cyanoacrylate.

TREATMENT

Given the expansion of the right cSDH and persistent symptoms, the decision was made to perform MMA embolisation. The right MMA was selectively catheterised distal to the petrosal branch and revealed two pseudoaneurysms within the parietal branch (figure 2A,B). Selective angiogram performed from the parietal branch (figure 2C,D) did not show any intracranial or orbital anastomoses so the decision was made to perform glue embolisation with 25% n-BCA, which is standard practice at our institution.[10] Initially, glue was seen filling the proximal aspect of the artery with subsequent direct filling of an anterior superior temporal branch of the middle cerebral with glue coursing medially (figure 3, online supplemental video). Injection was immediately stopped and the catheter was withdrawn under aspiration with a total of 0.4 cc of n-BCA instilled. Attention was then turned to the anterior division of the MMA, and 1.0 cc of glue was injected with filling of right frontal and parietal meningeal vessels with good contralateral penetration. A comparison of pre and post right common carotid artery angiograms confirmed glue within anterior temporal branch of the right MCA (figure 4).

OUTCOME AND FOLLOW-UP

Postprocedurally, the patient had an unchanged neurological status and returned to his inpatient rehabilitation centre. He underwent a non-contrast head CT following embolisation on postprocedure day 1 which confirmed glue embolic material within the right anterior superior temporal lobe (figure 5).

While in the rehabilitation centre, the patient demonstrated ongoing improvement in cognitive function with

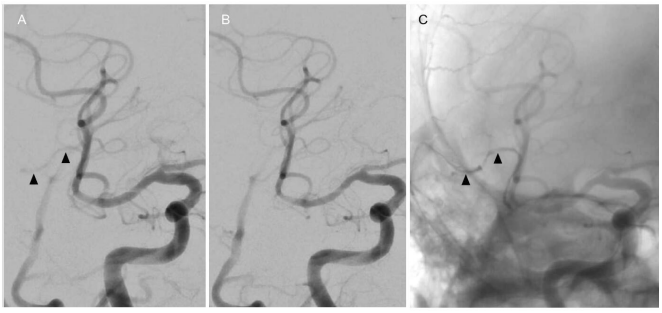

Figure 4 Pre-embolisation and post-embolisation right common carotid artery digital subtracted angiogram confirmed glue within anterior superior temporal branch of the right middle cerebral artery (A, B). Post-embolisation unsubtracted common carotid artery angiogram with glue cast within anterior temporal middle cerebral artery branch vessel (C).

discharge 2 weeks postprocedure. Outpatient follow-up head CT was performed 3 weeks post-embolisation that showed decreased thickness of subdural collection with decreased local mass effect and midline shift (figure 6). At the patient's follow-up clinic appointment 3 months following treatment, the patient was noted to have improved cognition, with desire to return to work.

DISCUSSION

Here, we describe the first known case of a post-traumatic meningio-pial anastomosis which was inadvertently embolised during MMA embolisation. This connection was not visualised on pre-embolisation superselective digital subtraction angiography performed with high pressure using a 1 cc syringe and for a prolonged duration as is typical for this procedure. In retrospect, however, inspection of pre-embolisation angiograms demonstrates apparent wash-out of contrast within the mid and distal portion of the parietal branch of the MMA, which could be explained by inflow from the subsequently embolised anterior temporal MCA branch (best seen in figure 2D).

Overall, this report describes a traumatic anastomosis which is an entity to be aware of in the setting of MMA embolisation following trauma with a fracture overlying the course of the meningeal vessels and in the presence of pseudoaneurysms. Selective catheterisation of the internal carotid artery prior to embolisation may be warranted in such cases, in addition to consideration of coil embolisation or conservative management.

While off-label use of embolics for MMA embolisation has become common internationally in recent years, with safety and efficacy supported by numerous large cohort studies, there are notably ongoing and future randomised controlled trials comparing MMA embolisation plus standard management to standard management alone in patients with cSDH, the results of which will provide highest level evidence regarding safety, efficacy and indications for this procedure.[11–15]

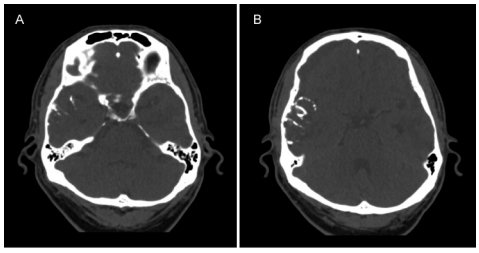

Figure 5 Post-embolisation non-contrast head CT which confirmed glue embolic material within the right anterior (A) and superior temporal lobe (B).

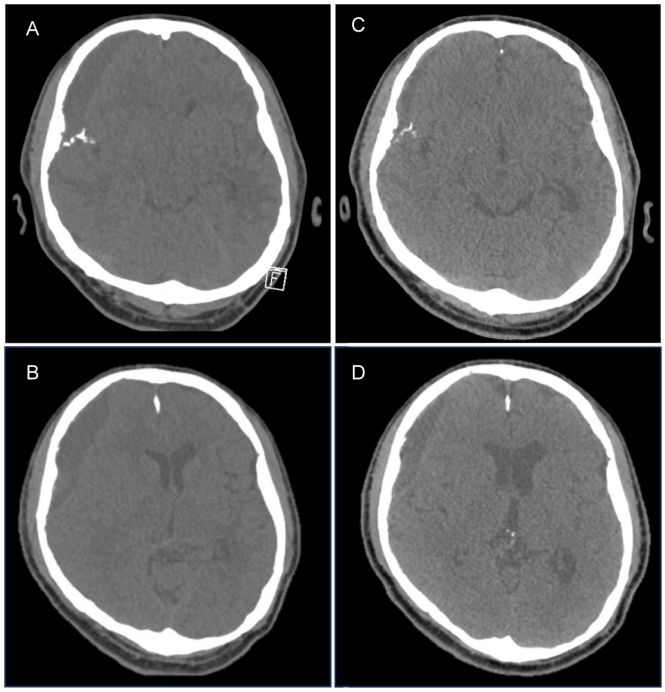

Figure 6 Immediate post-embolisation head CT (A, B) and follow-up head CT performed 3 weeks following embolisation (C, D). There is decreased thickness of subdural collection with decreased local mass effect and midline shift.

Learning points

- We describe the first known case of a post-traumatic meningio-pial anastomosis which was inadvertently embolised during middle meningeal artery (MMA) embolisation.
- Traumatic middle meningeal artery to middle cerebral artery anastomosis is an entity to be aware of in the setting of MMA embolisation following trauma with a fracture overlying the course of the meningeal vessels and in the presence of pseudoaneurysms.
- Selective catheterisation of the internal carotid artery prior to embolisation may be warranted in such cases, in addition to consideration of coil embolisation or conservative management.

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Contributors All authors were involved in the clinical care of the patient, gave final approval of the article are responsible for the drafting of the text, sourcing and editing of clinical images, investigation results, drawing original diagrams and algorithms, and critical revision for important intellectual content, and are accountable for the content of article and ensure that all questions regarding the accuracy or integrity of the article are investigated and resolved.

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Case reports provide a valuable learning resource for the scientific community and can indicate areas of interest for future research. They should not be used in isolation to guide treatment choices or public health policy.

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