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Case report

# Flow-directed micro-catheterisation technique over a detachable coil

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## SUMMARY

Embolisation of neonatal arteriovenous shunts poses several challenges: tortuous and fragile vessels, limited contrast volume and few specialised paediatric endovascular devices. In a 9-day-old patient with a choroidal type vein of Galen malformation we encountered an extremely tortuous posterior choroidal artery pedicle during endovascular treatment. After attempted selection using a traditional over-the-wire technique, we advanced a platinum coil through the micro-catheter. High flow within the feeder directed the soft and malleable coil antegrade. We then advanced the catheter over the coil's pusher wire in a facile manner to an ideal position for embolisation. This approach may be especially useful in cases requiring coil/vinyl-based liquid embolics, given that the only flow-directed micro-catheter available to most operators is compatible with n-Butyl cyanoacrylate alone. Moreover, the soft distal portion of coil may impart a safety benefit over traditional guidewires in easily perforated neonatal vasculature.

## BACKGROUND

Transarterial endovascular embolisation is the preferred treatment for appropriately selected neonates with intracranial high flow arteriovenous shunts such as vein of Galen malformation (VOGM). Although reducing flow through the fistula(e) is sufficient to improve cardiac function and neurological outcome, the numerous overlapping, tortuous and fragile pedicles often complicate endovascular access.<sup>1,2</sup> Here, we present a patient with choroidal type VOGM resulting in high output congestive heart failure who required urgent embolisation as a life-saving measure. The size, number and configuration of feeding pedicles necessitated use of coils as well as both acrylic and vinyl liquid embolics. Lack of a true flow-directed micro-catheter versatile enough to accommodate these various embolic materials proved an immediate challenge, especially given limited contrast and radiation dose. To our knowledge, this is the first report to describe a flow-directed micro-catheterisation technique over a detachable coil. This improvisation allowed the operators to safely and quickly navigate into a tortuous feeder when conventional over-the-wire approach proved ineffective.

## CASE PRESENTATION

The patient is a full-term female neonate who, following an uncomplicated gestation, was

delivered by caesarean section due to failure to progress through labour. At birth, respiratory distress necessitated emergent intubation. Further evaluation revealed high output congestive heart failure due to choroidal VOGM. Despite maximal medical care in the neonatal intensive care unit, the patient's cardiac function progressively declined over her first few days of life. At this point, we chose to proceed with endovascular embolisation.

## INVESTIGATIONS

Cranial ultrasound performed on postnatal day 0 demonstrated a large midline hypoechoic, hypervascular structure. MRI/Magnetic Resonance Angiography (MRA)/Magnetic Resonance Venography (MRV) of the brain performed on postnatal day 2 showed numerous enlarged, tortuous arteries feeding into an aneurysmal dilation of the proencephalic vein of Markowski (figure 1). Catheter angiography of the left Internal Carotid Artery (ICA), right ICA and right vertebral artery performed on days of life 6, 9 and 14, respectively, confirmed the findings noted on noninvasive imaging. The choroidal type VOGM was supplied by bilateral anterior and posterior medial/lateral choroidal arteries as well as by vermian branches of Superior Cerebellar Artery (SCA) and Posterior Inferior Cerebellar Artery (PICA), anterior cerebral artery limbic collaterals and even the Middle Cerebral Artery (MCA). Most of these pedicles converged upon an ampulla leading into the aneurysmal venous pouch. Drainage was through a falcine sinus and subsequently into the bilateral sigmoid sinuses.

## TREATMENT

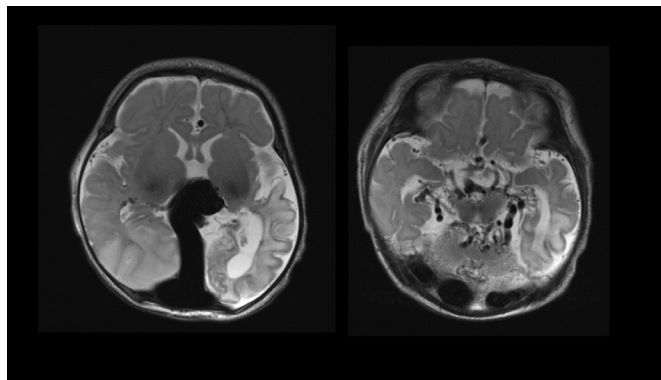
The VOGM was treated in a staged fashion over three embolisation sessions to minimise contrast dose, fluoroscopy and anaesthesia time. Following each session, the patient's cardiac and other clinical parameters were reassessed to determine whether additional embolisation was necessary.

By the third embolisation her cardiac function had modestly improved and our therapeutic goal focused on reaching a point where she could be extubated. However, with the largest and most easily accessible pedicles already occluded, selecting the next target vessel, a high flow feeder arising from the right posterior lateral choroidal artery, proved challenging. This pedicle originated from the PCA at a <90° angle then described a tortuous course with >360 degrees of curvature. We planned



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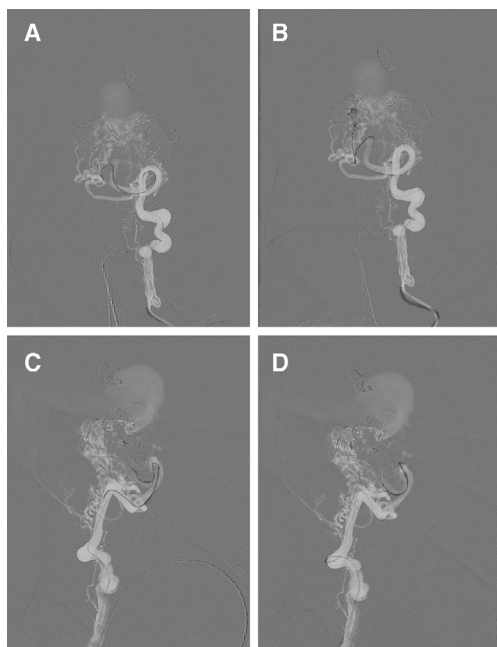
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**Figure 1** T2 axial MRI showing the vein of Galen malformation and multiple bilateral choroidal feeders.

to first attempt coil embolisation of the ampulla to reduce inflow from several pedicles at once. However, if a stable ampullary coil mass could not be achieved, we would coil the selected pedicle alone prior to injecting liquid embolic in order to prevent untoward glue embolisation and catastrophic thrombosis of the venous outlet.

A marathon micro-catheter was chosen, as it demonstrated some flow-directed properties and could also accommodate certain detachable coils. Despite advancing the catheter alone as well as over Synchro 0.10' and Asahi 0.008' micro-guide-wires, the system would not advance beyond the posterior lateral choroidal artery origin. Although frustrated and prepared to conclude the procedure, we thought to first test an idea of advancing a coil (Barricade Helical Finishing Coil 2 mm x 6 cm, Balt USA) as a flow-directed selection device. Its behaviour pleasantly surprised: as the coil was advanced through the tip of the micro-catheter it flowed along the path of least vascular resistance, entering the target pedicle, across the fistula and looping



**Figure 2** Digital Subtraction Angiography (DSA) images showing coil advanced into right posterior lateral choroidal artery feeding pedicle on Anterior-Posterior (AP) (A) and lateral (C) projections, and with micro-catheter having been advanced over the coil to a suitable position for embolisation on AP (B) and lateral (D) projections.



**Video 1** AP at lateral fluoroscopy sequences showing coil advancement into the right posterior lateral choroidal artery feeding pedicle and advancement of the micro-catheter over the stiff portion of the coil.

within the venous pouch. We then advanced the micro-catheter over the stiff pusher-wire portion of the coil to an optimal position for embolisation (figure 2, video 1). As the ampulla proved too wide for stable coil embolisation, we proceeded to coil and glue to distal posterior lateral choroidal artery pedicle itself.

#### OUTCOME AND FOLLOW-UP

Following the third embolisation the patient's cardiorespiratory status improved to the point where an endotracheal tube weaning trial could be initiated. Post-treatment MRI of the brain showed no new areas of infarct or haemorrhage.

#### DISCUSSION

Flow-directed neuro-navigation represents a useful strategy for selecting pedicles feeding into arteriovenous shunts. These pedicles are typically fragile and tortuous, limiting the safety and efficacy of conventional over-the-wire manipulation. However, in situations where embolics other than *n-Butyl cyanoacrylate* (n-BCA) are desired, the interventionalist's choice of flow-directed micro-catheters is quite limited.

The presently described technique allows one to proceed with a versatile micro-catheter compatible with acrylic and vinyl embolics as well as coils. Once the soft distal portion of a detachable coil is advanced through the catheter and surrounded by brisk flow, it responds by floating anterograde despite vessel tortuosity. As a sufficient length of coil becomes extruded, the proximal pusher-wire portion then serves as a conventional

#### Learning points

- ▶ Flow-directed neuro-navigation is a useful strategy for selecting pedicles feeding into arteriovenous shunts that are not amenable to conventional over-the-wire manipulation due to their tortuosity and fragility.
- ▶ When embolics other than n-BCA are necessary, there are few choices of truly flow-directed micro-catheters. However, a more versatile catheter can demonstrate flow-directed behaviour if paired with a coil, as detailed in this study.
- ▶ Using the flow-directed micro-catheterisation technique over a detachable coil may enable one to select and embolise feeding pedicles that would have been otherwise inaccessible and avoid resorting to high risk strategies such as transvenous embolisation.

micro-guidewire, allowing one to advance the catheter over it to a position suitable for embolisation.

While treating the aforementioned neonatal VOGM, this technique allowed us to select and embolise a feeding pedicle that would have been otherwise inaccessible. The concept of flow-directed catheter access is well established and commonly used during treatment of vascular malformations.<sup>3–5</sup> More specifically, a form of flow-directed coiling was described by Teitelbaum *et al* wherein a coil mass is formed within a high flow pedicle and then intentionally dislodged and allowed to travel distally.<sup>6</sup> However, to our knowledge there has been no published description of using the tip of a detachable coil as a flow-directed micro-catheterisation technique.

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