CASE REPORT

Posterior meningeal artery DMSO injection resulting in reproducible asystole prior to Onyx therapy of a dural arteriovenous fistula: a previously undescribed variant of the trigeminocardiac reflex or a new phenomenon?

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SUMMARY

We describe a case of reproducible asystole during endovascular treatment of a posterior fossa dural arteriovenous fistula. Catheterisation of the posterior meningeal artery, a branch of the vertebral artery in this patient, followed by dimethyl sulfoxide injection prior to Onyx administration resulted in two episodes of asystole. To the best of our knowledge, this is the first reported case of asystole occurring during endovascular intervention in the posterior meningeal artery. This may represent a previously undescribed variant of the trigemino-cardiac reflex (TGCR) caused by chemical stimulation of small areas of trigeminally innervated posterior fossa dura. Alternatively, this may represent a newly identified phenomenon with chemical stimulation of regions of posterior fossa dura innervated by branches of the vagus nerve leading to increased parasympathetic activity and resultant asystole.

In either case, it is important to recognise the potential for such episodes in this vascular territory to allow case planning and management.

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CASE PRESENTATION

A 48-year-old woman was presented with a subarachnoid haemorrhage secondary to a ruptured anterior communicating artery aneurysm (WFNS grade 1, Fisher grade 3). She underwent cerebral angiography and uncomplicated coiling of a 4 mm anterior communicating artery aneurysm on day 1 post-ictus and subsequently recovered well.

On DSA performed as part of the aneurysm treatment, a posterior fossa dural arteriovenous fistula (dAVF) was incidentally detected. The lesion was supplied by the posterior meningeal artery, arising from the left vertebral artery (figures 1 and 2); it shunted directly into a superior vermian vein which then emptied into the vein of Galen (Congard grade 3). After discussing the risks and benefits of dAVF

BACKGROUND

Previous reports describe episodes of asystole during endovascular intervention in arteries, supplying the dura of the middle cranial fossa, most commonly involving the middle meningeal artery.^{1 2} These episodes have been attributed to the trigeminocardiac reflex (TGCR), a brainstem reflex in which stimulation of sensory branches of the trigeminal nerve, which innervates the dura in this region, leads to increased vagal parasympathetic activity and asystole.

To the best of our knowledge, this is the first report of a similar episode of asystole occurring on endovascular intervention in the posterior meningeal artery, an artery supplying the dura of the posterior cranial fossa where there is minimal trigeminal dural innervation.

This case may represent an unusual variant of TGCR or possibly a new phenomenon due to stimulation of sensory branches of the vagus nerve. In either case, it is important to recognise the potential

Figure 1 Lateral digital subtraction angiograms of the posterior fossa. An angiogram is performed via a catheter (small white arrow) within the left vertebral artery (small black arrow). The dural arteriovenous fistula (large white arrow) is well demonstrated arising from the posterior meningeal artery (large black arrow).

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Figure 2 Lateral digital subtraction angiograms of the posterior fossa. An angiogram is performed via a catheter (small white arrow) within the left vertebral artery (small black arrow). The dural arteriovenous fistula (large white arrow) is well demonstrated arising from the posterior meningeal artery (large black arrow).

embolisation, the patient re-attended our institution for treatment 2 weeks after her aneurysm coiling.

TREATMENT

The treatment of dAVF was performed under general anaesthesia, which was induced with rocuronium 50mg, midazolam 2mg and fentanyl 100mcg. The patient was intubated and mechanically ventilated with FiO₂ 0.5 with 500mL tidal volumes at a rate of 12 breaths per minute. Anaesthesia was maintained with a propofol target controlled infusion at a rate of 3.8mcg/mL. A metaraminol infusion was also used to maintain the patient's blood pressure at her pre-anaesthetic level of 140mmHg. Invasive cardiovascular monitoring via an arterial line was used during the entire procedure.

Using a 6 French guide catheter system, a Headway Duo (Microvention, Tustin, California, USA) microcatheter was advanced into the left posterior meningeal artery branch of the left vertebral artery to a point just below the torcula (figure 3). Injection of dimethyl sulfoxide (DMSO) into the microcatheter with the intention of using Onyx (Covidien, Irvine, California, USA) caused asystole lasting ~30 s. Glycopyrolate 0.2mg was administered and the asystole resolved with the heart rate returning to normal. Following this, a microcatheter angiogram was performed which flushed out the residual DMSO from within the microcatheter dead-space. This precipitated a second period of asystole lasting 15 s.

The planned use of Onyx was abandoned and the fistula was embolised with 33% GluBran2 (Viareggio, Italy). A complete angiographic occlusion was achieved with the penetration of glue to the venous side of the dAVF (figures 4 and 5).

OUTCOME AND FOLLOW-UP

Neostigmine 2.5mg, glycopyrolate 0.4mg and ondansetron 4mg were administered intravenously at the end of the anaesthetic and the patient awoke with no neurological deficit. She

Figure 3 Lateral digital subtraction angiogram of the posterior fossa. The microcatheter (small white arrow) has been positioned within the posterior meningeal artery (large black arrow). A microcatheter angiogram again demonstrates the dural arteriovenous fistula (large white arrow) and also demonstrates reflux into a superior vermian vein (small black arrow).

was given a further 0.2mg glycopyrolate, a 1 hr post-procedure for sinus bradycardia at a rate of 35–40 beats per min. Her haemodynamic parameters were monitored noninvasively for 24 hours, and she was discharged on day 2 post treatment. On 6-week review in outpatient clinic, the patient was well with no sequelae.

DISCUSSION

Prior case reports attribute episodes of bradycardia and asystole occurring during endovascular neurointerventional procedures to the central subtype of the TGCR.^{1,2}

The TGCR is a brainstem reflex believed to be related to the diving reflex in humans which was first described in ophthalmic and neurological neurosurgery.³ Stimulation of sensory branches of the trigeminal nerve triggers the afferent limb of the reflex which may be classified as central or peripheral, depending on whether the sensory branches innervate intra-cranial (central TGCR) or extra-cranial (peripheral TGCR) structures.³ Neuronal impulses are relayed to the sensory nucleus of the trigeminal nerve within the brainstem via the Gasserian ganglion. These impulses are transmitted via short internuncial fibres in the reticular formation to instigate the efferent limb of the reflex through parasympathetic neurons in the motor nucleus of the vagus nerve.⁴ This increased vagal parasympathetic activity manifests as bradycardia, which may be profound, only rarely progressing to complete asystole.⁵

Although the TGCR is more commonly encountered during open neurosurgical procedures,^{6–8} several endovascular procedures have been linked to episodes of TGCR. These include balloon embolisation of a carotid cavernous fistula, contrast injection into the middle meningeal artery and most commonly the use of DMSO and Onyx in the treatment of dAVF.^{4,8–11}

Figure 4 Lateral skull radiograph. The Gluebrán cast can be identified following embolisation of the posterior fossa dural arteriovenous fistula (white arrow).

It has been theorised that either a mechanical stimulus, such as balloon angioplasty, or a chemical stimulus, such as DMSO injection, may irritate sensory branches of the trigeminal nerve within the dura instigating the reflex.

Episodes of TGCR-related complete asystole during endovascular cerebral arterio-venous interventions are rare²³ and on review of the literature, a pre-requisite for the occurrence of TGCR appears to be intervention in an artery supplying dura innervated by the trigeminal nerve.¹⁰ Our case is unique

Figure 5 Lateral digital subtraction angiogram of the posterior fossa. Final angiogram demonstrates complete occlusion of flow into the dural arteriovenous fistula from the posterior meningeal artery with the stump of the posterior meningeal artery still visualised (white arrow).

as the episode of asystole occurred during an endovascular intervention within the posterior meningeal artery, an artery relatively uncommonly used for endovascular embolisation procedures and branch of the vertebral artery in this patient. The posterior meningeal artery supplies the posterior fossa; the dura of which is largely innervated by branches of the upper three cervical nerves, the hypoglossal nerve and recurrent sensory branches of the vagus nerve rather than the trigeminal nerve.¹²

There are two possibilities to explain the occurrence of asystole in this case. First, this case may represent a previously undescribed variant of the TGCR, caused by stimulation of sensory branches of the trigeminal nerve which innervate areas of the posterior fossa dura in this particular patient. Indeed, innervation of parts of the cerebellar tentorium by the nerve of Arnold, a recurrent branch of the ophthalmic division of the trigeminal nerve has been reported¹³ as has arterial supply of the cerebellar tentorium by the posterior meningeal artery.¹⁴ In addition, open neurosurgical procedures of the cerebellar tentorium have rarely produced TGCR-like episodes.¹⁵¹⁵

Alternatively, the asystole in this case may be unrelated to the TGCR and instead due to a previously undescribed phenomenon. Recurrent branches of the vagus nerve are known to contribute to dural innervation in the posterior fossa^{8 12}; these branches may have been stimulated by DMSO injection into the posterior meningeal artery leading to elevated vagal parasympathetic activity and subsequently asystole.

Whether our case represents an unusual variant of TGCR or a new phenomenon caused by direct stimulation of recurrent branches of the vagus nerve; the recognition of the potential for occurrence of such episodes allows appropriate case planning and management. There is no known cardiac or other comorbidities which predispose to vagal episodes associated with intracranial intravascular DMSO but it seems reasonable to pre-medicate patients deemed less likely to tolerate transient asystole with anti-vagal agents such as atropine or glycopyrrolate.

Learning points

- ▶ This is the first report of reproducible asystole occurring during endovascular intervention in the posterior meningeal artery.
- ▶ This case could represent a previously undescribed variant of the trigeminocardiac reflex caused by chemical stimulation of small areas of trigeminally innervated posterior fossa dura.
- ▶ This case may represent a newly identified phenomenon whereby chemical stimulation of regions of posterior fossa dura innervated by branches of the vagus nerve leads to increased parasympathetic activity and resultant asystole.
- ▶ Whether our case represents an unusual variant of TGCR or a new phenomenon caused by direct stimulation of recurrent branches of the vagus nerve; the recognition of the potential for occurrence of such episodes allows appropriate case planning and management.

Contributors MTC: writing of paper and collating images. AER: literature search, initial drafts of sections of paper, image editing. HA: writing sections of paper regarding anaesthesia. TJP: editing of final draft of paper, overseeing project.

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REFERENCES

- Schaller B, Probst R, Strebel S, *et al*. Trigemino-cardiac reflex during surgery in the cerebellopontine angle. *J Neurosurg* 1999;90:215–20.
- Lv X, Li Y, Lv M, *et al*. Trigemino-cardiac Reflex in Embolization of Intracranial Dural Arteriovenous Fistula. *American Journal of Neuroradiology* 2007;28:1769–70.
- Meuwly C, Golanov E, Chowdhury T, *et al*. Trigeminal cardiac reflex: new thinking model about the definition based on a literature review. *Medicine* 2015;94:e484.
- Tamura T, Rex DE, Marosfoi MG, *et al*. Trigemino-cardiac reflex caused by selective angiography of the middle meningeal artery. *BMJ Case Rep* 2016;1.
- Li C, Yang X, Li Y, *et al*. Endovascular treatment of Intracranial Dural Arteriovenous Fistulas presenting with Intracranial hemorrhage in 46 Consecutive patients: with emphasis on Transarterial embolization with Onyx. *Clin Neuroradiol* 2016;26:301–8.
- Schaller B. Trigemino-cardiac reflex. A clinical phenomenon or a new physiological entity? *J Neurol* 2004;251:658–655.
- Spiriev T, Kondoff S, Schaller B. Trigemino-cardiac reflex during temporary clipping in aneurysmal surgery: first description. *J Neurosurg Anesthesiol* 2011;23:271–2.
- Chowdhury T, Schaller B. The negative chronotropic effect during lumbar spine surgery: A systemic review and aggregation of an emerging model of spinal cardiac reflex. *Medicine* 2017;96:e5436.
- Varadharajan S, Ramalingaiah AH, Saini J, *et al*. Sustained trigemino-cardiac reflex following balloon embolization of carotico-cavernous fistula. *Interv Neuroradiol* 2016;22:577–8.
- Lv X, Li Y, Jiang C, *et al*. The incidence of trigemino-cardiac reflex in endovascular treatment of dural arteriovenous fistula with onyx. *Interv Neuroradiol* 2010;16:59–63.
- Lv X, Li Y, Lv M, *et al*. Trigemino-cardiac reflex in embolization of intracranial dural arteriovenous fistula. *AJNR Am J Neuroradiol* 2007;28:1769–70.
- Kemp WJ, Tubbs RS, Cohen-Gadol AA. The innervation of the cranial dura mater: neurosurgical case correlates and a review of the literature. *World Neurosurg* 2012;78:505–10.
- Penfield W. Dural headache and innervation of the Dura mater. *Arch Neurol Psychiatry* 1940;44:43–75.
- Newton TH. The anterior and posterior meningeal branches of the vertebral artery. *Radiology* 1968;91:271–9.
- Bauer DF, Youkilis A, Schenck C, *et al*. The falcine trigemino-cardiac reflex: case report and review of the literature. *Surg Neurol* 2005;63:143–8.

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