CASE REPORT

Acute subarachnoid hemorrhage in posterior condylar canal dural arteriovenous fistula: imaging features with endovascular management

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SUMMARY

A 43-year-old man presented with acute subarachnoid hemorrhage. He was investigated and found to have a rare posterior condylar canal dural arteriovenous fistula (DAVF). DAVFs of the posterior condylar canal are rare. Venous drainage of the DAVF was through a long, tortuous, and aneurysmal bridging vein. We describe the clinical presentation, cross sectional imaging, angiographic features, and endovascular management of this patient. The patient was treated by transarterial embolization of the fistula through the ascending pharyngeal artery. This is the first report of an acutely bled posterior condylar canal DAVF treated by transarterial Onyx embolization with balloon protection in the vertebral artery. The patient recovered without any neurological deficit and had an excellent outcome. On 6 month follow-up angiogram, there was stable occlusion of the dural fistula.

BACKGROUND

Dural arteriovenous fistulas (DAVFs) involving the posterior condylar canal (PCC) are rare, with a single report describing a PCC DAVF.¹ However, there are no reports of transarterial Onyx embolization with balloon protection in the vertebral artery (VA) as an endovascular technique to treat this rare DAVF. This case report emphasizes the rarity, variable angioarchitecture, and presentation of a PCC DAVF, the technical challenges in its treatment, and reviews open neurosurgical and endovascular strategies.

CASE PRESENTATION

A 43-year-old man complained of sudden onset severe headache, vomiting, and vertigo. On examination, the patient was drowsy but otherwise normal. There was severe neck rigidity. There were no cerebellar signs.

INVESTIGATIONS

Non-contrast CT showed acute subarachnoid hemorrhage in the cerebello-medullary cistern with intraventricular hemorrhage (figure 1A). CT angiogram revealed a right PCC DAVF (figure 1B, C). MRI demonstrated a large venous pouch in the fourth ventricle with a daughter sac pointing posterosuperiorly. The VAs supplied the fistula that drained into a complex tangle of veins posterior to the medulla (figure 2A–C).

On DSA, a PCC DAVF was discovered, supplied by an enlarged neuromeningeal trunk of the

ascending pharyngeal artery, C1 cervical dural branches from both VAs, and from the left posterior meningeal artery. A single, long, and tortuous medullary bridging vein (BV) in the cerebello-medullary cistern drained the fistula. This BV drained into the junction of the median posterior medullary vein and the vein of the left inferior cerebellar peduncle and subsequently into the vein of lateral recess of the fourth ventricle with a large venous pouch. These veins drained into the superior petrosal sinus and subsequently into the left transverse sigmoid sinus and the median posterior medullary vein into the perimedullary venous plexuses (figure 3A–D).

TREATMENT

The patient was scheduled for transarterial embolization of the DAVF. The anticoagulation regimen followed was an intravenous bolus dose of unfractionated heparin 50–100 IU/kg at the start of the procedure followed by intermittent boluses of 10–20 IU/kg to maintain a target activated clotting time of 250–300 s. A 4×20 mm Hyperglide balloon (Covidien, Mansfield, Massachusetts, USA) was inflated across the origin of the C1 cervical branches in the VA. A Marathon microcatheter (Covidien) over a Mirage microwire (Covidien) was navigated close to the fistulous point, and an angiogram showed the DAVF with a large venous pouch (figure 3D, E). Onyx-34 (1 mL) followed by 0.5 mL of Onyx-18 (Covidien) was injected through the microcatheter over 45 min to occlude the fistula (figure 3F). Post embolization, there was complete exclusion of the fistula and its venous aneurysm from the circulation.

OUTCOME AND FOLLOW-UP

Post procedure, the patient had an uneventful recovery. An immediate post-procedural CT showed no acute intracranial hemorrhage with Onyx cast in the PCC (figure 1D). A follow-up MRI at 1 month showed the absence of perimedullary flow voids and venous aneurysm (figure 2D). Repeat cerebral DSA and MRI obtained at 6 and 12 months, respectively, revealed stable occlusion of the fistula. The patient remained asymptomatic with no new neurological deficits.

DISCUSSION

Radiological anatomy of the PCC

The PCC is the largest and most constant emissary foramen in the human skull.² It transmits the

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Figure 1 (A) Non-contrast CT scan at the level of the mid-pons shows the fourth ventricular hemorrhage (asterisk). (B) Coronal CT angiogram through the posterior condylar foramina (black arrows) shows a right posterior condylar canal dural arteriovenous fistula (arrow). A complex tangle of dilated and tortuous veins with a large venous aneurysm in the fourth ventricle and a daughter sac is seen (arrowhead). (C) Coronal (volume rendered) CT angiogram image after bone removal shows a right posterior condylar dural fistula (arrow). The daughter sac points posterosuperiorly (arrowhead). (D) A high resolution CT scan of the skull base through both the posterior condylar foramina (white arrows) after transarterial embolization shows the Onyx cast in the right posterior condylar canal.

Figure 2 (A, B) Axial T2 weighted and time of flight MR angiogram shows multiple convoluted and enlarged vascular channels extending from the right posterior condylar foramen into the cerebello-medullary cistern (arrow). (C) Sagittal T2 weighted image shows a large venous pouch (arrowhead) located in the fourth ventricle with multiple flow voids in the cerebello-medullary cistern. (D) Post embolization, axial T2 weighted image through the skull base shows Onyx cast in the right posterior condylar canal dural arteriovenous fistula extending into the cerebello-medullary cistern (long arrow). The asterisks denote occipital condyles and the short white arrows the posterior condylar canals.

Figure 3 (A–C) Right vertebral, left vertebral, and ascending pharyngeal angiograms reveal a right posterior condylar canal dural arteriovenous fistula (DAVF) (arrows) supplied by an enlarged neuromeningeal trunk, C1 cervical dural branches from both vertebral arteries, and left posterior meningeal artery. The fistula is drained by a single long and tortuous medullary bridging vein that drains to the vein of lateral recess of the fourth ventricle with a large venous pouch (arrowhead). (D, E) Microcatheter angiograms in Towne's and lateral view show the location of the right posterior condylar canal DAVF (arrow). A complex tangle of dilated and tortuous veins with a large venous pouch in the fourth ventricle is seen (arrowhead). (F) Fluoroscopic lateral view of the skull base shows Onyx cast in the right posterior condylar canal (black arrow). A balloon (asterisk) is seen inflated across the origin of the dural branches of the right vertebral artery with the microcatheter in the right ascending pharyngeal artery.

posterior condylar vein that drains the distal sigmoid sinus/jugular bulb into the deep cervical vein and VA venous plexuses.³ It also transmits a meningeal branch of the occipital artery (figure 4).⁴

Definition, anatomy, and embryology of 'BV-DAVFs'

The term 'BV-DAVFs' was first used by Mitsuhashi *et al*⁵ to describe DAVFs at the craniocervical junction that drained through BVs: the union of terminal ends of the brainstem and cerebellar veins form BVs.⁶ These BVs collect into the galenic group that drains into the vein of Galen, the petrosal group that drains into the petrosal sinuses, and the tentorial group that drains into sinuses converging on the torcular Herophili. They also drain into veins in the hypoglossal canal, marginal sinus, jugular bulb, suboccipital cavernous sinus, and tentorial sinuses.^{6,7}

In the fourth week of embryological development, multiple transverse veins develop on the surface of the neural tube that differentiate to form the adult pial venous anastomotic network around the brainstem. BVs are derived by incorporation of embryological ventral myelencephalic, hypoglossal, and first cervical intersegmental veins. This network accounts for the variable configuration and interconnections between leptomeningeal veins draining the brainstem, BVs, and venous sinuses.^{6,7} In the present case, the BV was found to interconnect the posterior condylar vein with the vein of the inferior cerebellar peduncle and the median posterior medullary vein.

Clinical features of BV-DAVFs

BV-DAVFs are embryological homologs of lateral epidural spinal and petrosal vein DAVFs. The high incidence of hemorrhage in these DAVFs is due to tortuous and ectatic leptomeningeal veins that rupture from high systemic arterial pressure of the

Figure 4 Diagrammatic representation of the posterior fossa illustrating the arterial blood supply and venous outflow of the posterior condylar canal dural arteriovenous fistula. (1) V3 segment of the vertebral artery. (2) C1 cervical dural branches (asterisks denote posterior condylar canals). (3) Posterior meningeal artery. (4) Bridging vein (blood flow depicted by white arrows). (5) Vein of lateral recess of the fourth ventricle (blood flow depicted by green arrows). (6) Transverse nodulo-uvular vein. (7) Vein of inferior cerebellar peduncle (blood flow depicted by orange arrows). (8) Posterior median medullary vein. (9) Perimedullary venous plexus. (10) Lateral medullary vein→lateral pontine vein→anterior cerebellar vein (blood flow depicted by yellow arrows). (11) Petrosal vein. (12) Superior petrosal sinus. (13) Lateral mesencephalic vein. (14) Posterior mesencephalic vein. (15) Straight sinus and vein of Galen. ACC, anterior condylar confluent; BA, basilar artery; IJV, internal jugular vein; JB, jugular bulb; PCA, posterior cerebral artery; PCV, posterior condylar vein; SS, sigmoid sinus; TS, transverse sinus; VA, vertebral artery.

fistula.^{5 8} However, in the PCC DAVF described by Kiyosue *et al*,¹ the patient had presented with pulse synchronous tinnitus alone and no intracranial hemorrhage.

Management of BV-DAVFs

The surgical management of condylar canal DAVFs involves direct microsurgical interruption of the arterialized draining vein. Several surgical approaches have been described. However, surgical resection is difficult due to the intraosseous location, difficult access, difficulty in localizing the fistula, excess blood loss, and craniocervical instability following condylar resection.⁹

Endovascular management involves a transarterial, transvenous, or a combined approach.^{5 9} The transvenous approach, although widely advocated, has its disadvantages, namely: difficult access in the presence of sinus stenosis and tortuosity, a risk of wire perforation and bleed, cranial nerve injury, incomplete occlusion with venous flow redistribution to normal veins, and venous hypertension.⁹ Transarterial embolization with liquid embolic agents has an inherent high risk of cranial nerve palsy and migration to the vertebrobasilar circulation.⁹

In the case described by Kiyosue *et al*,¹ a transvenous approach was used. It was successful because the affected vein

was easily accessible, did not drain normal cerebral parenchyma, and could be safely occluded. However, in our case, the DAVF drained into a long and tortuous BV with a venous aneurysm and stenosis in the draining superior petrosal sinus. Hence retrograde catheterization was technically challenging with a high risk of wire perforation and bleed. Thus a transarterial approach was preferred. To reduce the risk of hypoglossal nerve injury, distal catheterization of the fistula was achieved while diligently minimizing Onyx reflux. As an additional precaution, a balloon was inflated across the origin of the meningeal branches to discourage Onyx migration into the VA.¹⁰

Contributors USL and RS managed the case. PKM identified, drafted, and revised the paper. PKM and USL revised the draft paper. USL is the guarantor of the study.

Competing interests None.

Patient consent Obtained.

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Learning points

- Dural arteriovenous fistulas (DAVFs) involving the posterior condylar canal (PCC) are rare and may present with acute subarachnoid hemorrhage.
- PCC DAVFs may drain into one of the several bridging veins at the skull base.
- PCC DAVFs are difficult to treat by surgical resection alone and are good candidates for endovascular Onyx or glue embolization to achieve stable occlusion.
- A thorough knowledge of the relevant angioarchitecture and various endovascular techniques is essential to obtain a good clinical outcome.

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