Vertebralbasilar junction (VBJ) aneurysms are uncommon and are often found in association with basilar artery (BA) fenestration. The complex anatomical environment of the VBJ, and the complicated geometry of the fenestration make clipping of these aneurysms difficult. Therefore, endovascular treatment of these aneurysms is now widely accepted.

The authors describe the case of a 43-year-old woman with sickle cell anemia. She presented with subarachnoid hemorrhage. Digital subtraction angiography was performed and depicted multiple intracranial aneurysms. The patient had a left superior hypophyseal artery aneurysm, a right superior cerebellar artery–posterior cerebral artery aneurysm, and a VBJ aneurysm associated with a fenestration of the BA. The VBJ aneurysm was not identified on the initial angiogram and was only revealed after 3D rotational angiography was performed. The 3D reconstruction was critical to the understanding of the complex geometry associated with the fenestrated BA. The VBJ was reconstructed using a combination endovascular technique. The dominant limb of the fenestration was stented and balloon-assisted coiling was performed, followed by sacrifice of the nondominant vertebral artery using coils and the embolic agent Onyx. Postoperative angiography demonstrated successful occlusion of the aneurysm with reconstruction of the VBJ.

To the authors’ knowledge, this is the first report of a fenestrated VBJ aneurysm treated with the combination of stenting, balloon remodeling, coiling, and vessel sacrifice. Three-dimensional angiography was critical in making the correct diagnosis of the source of the subarachnoid hemorrhage and with operative planning.

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**Key Words**  • angiography  • basilar artery fenestration  • Onyx  • stent-assisted coil embolization  • vertebrobasilar junction aneurysm

**Case Report**

History and Examination. This 43-year-old woman affected by sickle cell anemia was transferred to our institution for the treatment of an acute SAH. Unenhanced CT scanning was performed and showed SAH (Fisher Grade 3) and a blood clot in the cerebellomedullary cistern (Fig. 1). The patient was comatose (Hunt and Hess Grade V), and she was intubated. After a ventricular drain was placed, the patient underwent digital subtraction angiography that depicted 2 intracranial aneurysms, a right superior cerebellar artery–posterior cerebral artery aneurysm, and a left superior hypophysal artery aneurysm. Neither aneurysm location could have easily accounted for the location of the perimedullary blood clot (Fig. 2). Therefore, the patient underwent 3D rotational angiography with temporary balloon occlusion of the right VA. The 3D rendering uncovered a fenestrated BA associated with a wide-necked aneurysm (Fig. 3).

Treatment. Because of the wide neck involving both proximal limbs, primary coiling could not be performed. The patient was given 325 mg aspirin rectally and 300 mg Plavix through a nasogastric tube. She was also given an intravenous bolus of 7000 U heparin to bring the
activated clotting time above 250 seconds. At this point the dominant limb of the fenestration was stented using a Neuroform stent (Boston Scientific). The stent extended from the intracranial left VA to the mid-BA (Fig. 4A). The aneurysm was catheterized from the right VA, and coils were placed into the aneurysm through the microcatheter from the right VA. However, stent-assisted coiling could not be performed because the coil mass extruded through the stent into the left limb of the fenestration (Fig. 4A). Therefore, a balloon was inflated inside the stent from the left, and the aneurysm was coiled from the right VA (Figs. 4B and 5B). The balloon remodeling within the stent maintained the patency of the left fenestration. However, the aneurysm dome could not be discretely coiled without extrusion into the right VA (Fig. 4C). Therefore, the decision was made to sacrifice the right VA above the takeoff of the right PICA. The dome of the aneurysm was coiled, and coils were placed into the distal right VA (Fig. 4D). Significant filling of the distal BA and aneurysm dome continued as the coil mass approached the take off of the PICA. At this point, Onyx embolic agent (MicroTherapeutics) was used to sacrifice the right VA above the PICA (Fig. 4E). To prevent anterograde migration of the Onyx through the coil mass and into the BA, the following steps were taken. The balloon was inflated inside the stent protecting the left fenestration and the BA, and Onyx was injected into the scaffold of the coil mass within the left fenestration (Onyx-34 was used instead of the less viscous Onyx-18). The end result was that the right VA ended in the PICA distribution (Figs. 4E and 5D), the left VBJ was reconstructed with the stent, and the aneurysm was secured with coils and Onyx (Figs. 4F and 6).

The electroencephalography findings, auditory brainstem responses, and somatosensory evoked potentials in both upper and lower extremities, which were monitored continuously during the surgery, did not change from preoperative recordings.

**Postoperative Course.** Postoperative CT scanning did not demonstrate evidence of procedure-related ischemic events. On Day 7 after the SAH, the patient developed clinically and angiographically confirmed vasospasm. She underwent aggressive medical and endovascular treatment, which prevented radiographic ischemic changes. She was weaned off the ventricular drain, and it was removed. She was discharged to a skilled nursing facility. At last clinical follow-up, 7 months after the SAH, the patient was verbally appropriate with residual left hemiparesis (modified Rankin Scale Score 4).

**Discussion**

The BA is formed by the coalescence of paired longitudinal neural arteries at the 5–8-mm stage of the embryo. Segmental duplication, otherwise known as fenestration, of the BA can occur as a result of failure of regression of the bridging arteries or failure of fusion of the neural arteries. Based on these 2 different embryological mechanisms, Kai et al. have suggested a BA fenestration classification. Type A has 2 proximal bifurcation points and a bridging artery associated with the fenestration, and Type B has a single bifurcation at the proximal site of the fenestration. According to this classification, our patient had a Type B fenestration with the aneurysm arising at the proximal end of the BA fenestration (Fig. 5A). The development of an aneurysm at the junction of a fenestrated BA is thought to be due to alterations in flow hemodynamics and anatomical defects of the vessel wall. Morphological investigations have disclosed medial defects in the wall of the BA at either end of the fenestrated segment.

Vertebrobasilar junction aneurysms, particularly those associated with fenestration, are difficult to characterize using traditional angiography. The competing flow from the contralateral VA often prevents complete opacification of the lesion. In our case, the initial cerebral angiogram did not demonstrate the true nature of the lesion (Fig. 2). Three-dimensional angiography was critical for identifying the presence of the fenestration. Fenestrated VBJ aneurysms have been treated with endovascular coiling in the past. However, this is the first report of a multimodality treatment using stent placement, balloon remodeling, detachable coils, and Onyx embolic agent to reconstruct the VBJ.

In our case surgical reconstruction was not feasible given the poor condition of the patient. Primary coiling of the lesion was attempted and failed because of the complex geometry of the lesion. Therefore the aneurysm was treated using a combination endovascular approach. The
Fenestrated vertebrobasilar junction aneurysm

**Fig. 3.** Left: A 2D angiogram showing an abnormality in the filling of the VBJ (arrow). Right: A 3D rotational angiogram with temporary balloon occlusion of the right VA clarified the anatomy of a fenestrated BA associated with a wide-necked aneurysm (arrow).

**Fig. 4.** Angiograms showing the endovascular treatment. A: Left VA image (late arterial phase). The dominant limb of the fenestration was stented; the stent extended from the intracranial left VA to the mid-BA (thin arrows). The aneurysm was catheterized from the right VA, but the coil mass continued to persist through the stent into the left and right fenestrations of the BA (thick arrow). B: Left VA image obtained after balloon-assisted coiling with the balloon deflated. The balloon catheter can be seen in the left VA (arrowhead). A balloon was inflated inside the stent from the left and the aneurysm was coiled from the right VA (arrow). C: Right VA image (early arterial phase). The aneurysm dome could not be discretely coiled without extrusion into the right VA. Therefore, the right VA was sacrificed. Detachable coils can be seen within the aneurysm and extending proximally down to the right VA (arrows). D: Right VA image (late arterial phase). As the coil mass approached the takeoff of the PICA (arrowhead) significant filling of the aneurysm and the BA was seen (arrows). E: At this point, Onyx-34 embolic agent was used to precisely occlude the right VA above the takeoff of the PICA (arrow). This late arterial phase right VA image demonstrates very sluggish flow within the coil/Onyx mass. The patient has been given heparin, but the arterial segment will thrombose above the takeoff of the PICA (arrow) once the heparin effect has worn off. F: Final left VA image. The left VBJ has been reconstructed with a Neuroform stent. The aneurysm dome is secured with detachable coils, and the nondominant right VA has been sacrificed above the takeoff of the PICA with a combination of coils and Onyx-34 embolic agent.
dominant limb of the VBJ was reconstructed using a self-
expanding stent. Then the aneurysm was coiled from the
nondominant VA while a balloon was inflated inside the
stent to maintain the patency of the left VA by preventing
coil herniation through the stent. One particularly chal-
lenging aspect of the case was sacrificing the nondomi-
nant VA precisely above the takeoff of the PICA. Onyx-
34 is a viscous form of the embolic agent used primarily
to treat high-flow arteriovenous fistulas, where the goal
is to limit distal embolization. Onyx-18 is a low-viscosity
formulation used for penetration of an arteriovenous mal-
formation nidus with a prolonged injection. We were able
to selectively and safely sacrifice the vessel by using the
higher viscosity Onyx-34 in combination with an intralu-
minal coil mass and distal balloon protection. The end re-
sult was obliteration of the aneurysm and reconstruction
of the VBJ with sacrifice of the nondominant distal VA.

**Conclusions**

The anatomy of these aneurysms is extremely com-
plex, and many of these lesions cannot be treated with stan-
dard endovascular treatment. By using a combination of
emerging technology we were able to reconstruct the VBJ
and protect the patient from aneurysmal rehemorrhage.

Vertebrobasilar junction aneurysms associated with
BA fenestration present unique diagnostic and therapeu-
tic challenges. Diagnosis is difficult and often requires the
use of 3D angiography. Modern combination endovascular
therapy is capable of treating even the most challenging of
these lesions.

**Disclaimer**

The authors report no conflict of interest concerning the mate-
rials or methods used in this study or the findings specified in this
paper.
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