Supraclinoid internal carotid artery fenestration with an associated aneurysm

Case report

MICHAEL J. BANACH, B.A., AND EUGENE S. FLAMM, M.D.

Division of Neurosurgery, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania

The case of an aneurysm occurring at the site of fenestration of the supraclinoid portion of the left internal carotid artery (ICA) is reported. A 37-year-old woman presenting with subarachnoid hemorrhage was found to have bilateral ICA aneurysms at the level of the posterior communicating arteries (PCoA's). The patient underwent right-sided craniotomy with uneventful clipping of the right PCoA aneurysm, and attempted clip placement on the contralateral left ICA aneurysm. The follow-up angiogram revealed a residual dome on the left ICA aneurysm, which was noted to originate at the proximal end of a fenestration of the left supraclinoid ICA. This represents the third reported case of fenestration of the intracranial ICA associated with an aneurysm. Intracranial artery fenestrations and their embryological origins are also reviewed.

KEY WORDS • internal carotid artery • fenestration • segmental duplication • intracranial aneurysm • subarachnoid hemorrhage • embryology

Fenestrations of partial duplications of cerebral arteries are rare but well-recognized congenital anomalies that may be associated with intracranial saccular aneurysms, either at the site of fenestration or at a separate site. The most common locations for these fenestrations include the anterior communicating artery (ACoA), the vertebrobasilar arteries, the anterior cerebral artery (ACA), and the middle cerebral artery (MCA). Fenestration of the supraclinoid portion of the internal carotid artery (ICA) is extremely rare, and to our knowledge is reported in only two previous cases.7,28

We present the case of a patient with a fenestration of the left supraclinoid ICA with an associated aneurysm at the proximal end of the fenestration.

Case Report

This 37-year-old right-handed woman presented at another hospital on April 24, 1992, for evaluation of the acute onset of severe global headache, "crushing pressure" in her head, nausea, and vomiting. No loss of consciousness or seizure activity was noted. She was otherwise healthy and was performing as an opera soloist at the time of onset of her symptoms but was unable to complete the performance. On examination, she was reportedly without focal neurological signs. A computerized tomography (CT) scan revealed a subarachnoid hemorrhage (SAH) localized to the suprasellar cisterns, the sylvian fissures (greater on the right than the left), and the interhemispheric fissure. Her headache improved over the next few days and she was reported to be neurologically normal. An angiogram obtained on April 27 was interpreted as showing bilateral posterior communicating artery (PCoA) aneurysms. She was transferred to our hospital for evaluation on April 30.

Examination. On transfer, the patient complained only of mild frontal headache and photophobia, and was noted to be without focal neurological signs. On review of the previous CT scan, the impression was that she had an SAH secondary to aneurysm rupture on the right side. She was placed on a course of nimodipine and dilantin and was taken to the operating room on May 1.

Operations. A right-sided pterional craniotomy was performed with uneventful clipping of the right PCoA aneurysmal neck. The exposure of the contralateral ICA appeared adequate for clipping the contralateral aneurysm, which was performed without complication. The patient had a benign postoperative course except for a mild right ptosis, which subsequently resolved. A follow-up angiogram on May 7 revealed a residual dome in the left supraclinoid ICA aneurysm, now noted to be located at the proximal end of a fenestration of
Supraclinoid internal carotid artery fenestration

the left ICA (Fig. 1). The patient was discharged home on May 11 and was subsequently readmitted on June 15, when she underwent a left pterional craniotomy with uneventful clipping of the left ICA aneurysm at the proximal site of the supraclinoid ICA fenestration. The PCoA arose from the anomalous loop of the fenestration, which necessitated two clips placed in strategic locations to stop flow into the aneurysm while preserving flow through the PCoA (Fig. 2).

Postoperative Course. The patient had an uneventful postoperative course and was discharged home on June 23, 1992.

Discussion

Embryological Origins of Intracranial Artery Fenestrations

Fenestrations or segmental duplications of the cerebral arteries are much less common congenital variations of the cerebral vasculature than segmental hypoplasia or aplasia. The most common intracranial site for fenestration is the ACoA, where the incidence ranges from 7.5% to 40% in autopsy studies. Embryologically, the artery is plexiform until approximately the 18-mm stage, when it gradually becomes a single channel at the 21- to 24-mm stage. An incomplete

FIG. 1. Left internal carotid angiograms, lateral (left) and anteroposterior (right) views, showing persistence of the aneurysm arising from a fenestrated supraclinoid internal carotid artery.

FIG. 2. Intraoperative photographs. ica = internal carotid artery; 3 = oculomotor nerve; on = optic nerve. Left: An aneurysm (open arrow) is seen arising from the duplicated segment (solid arrow) of the left internal carotid artery. Right: Appearance after clipping of the aneurysm (solid arrow) to preserve the origin of the posterior communicating artery which arose from the duplicated segment of the internal carotid artery.
fusion of this plexus may result in either segmental or complete doubling of this artery. Fenestrations of the basilar artery are found in approximately 1% to 5% of autopsy studies, occurring most often at the proximal portion, and are thought to result from incomplete fusion of the two primitive longitudinal arteries in the embryo at about the 5- to 9-mm stage. Vertebral artery fenestrations are reported in 1% to 2% of autopsy or angiographic studies. The vertebral artery forms from an anastomosis between the cervical intersegmental arteries during the 7- to 12-mm stage, at which point there is a transient basilar-vertebral artery anastomosis. A remnant of this channel may explain such a duplication. Fenestrations of the MCA and ACA are observed in 0.28% to 1% and 0.1% to 7.2% of autopsy studies, respectively. An ACA fenestration may form as a result of persistence of the plexiform anastomosis between the primitive olfactory artery and the ACA.

Fenestrations of the Supraclinoid Internal Carotid Artery

Fenestrations of the intracranial ICA appear to be extremely rare, with only two previously reported cases in the literature. The ICA arises from the third aortic arch at the 4- to 5-mm embryological stage. Near the summit of the optic vesicle, the primitive carotid artery divides to form the cranial and caudal divisions of the ICA. The cranial division gives rise to the anterior choroidal artery, MCA, and ACA, while the caudal division terminates as the PCoA. In the two previously reported cases, as in our patient, the fenestration of the ICA occurred at a site just distal to the origin of the ophthalmic artery, which corresponds to the site of division of the primitive ICA. An aberrant or anomalous division of the ICA may give rise to a fenestration at this site. At the 4- to 5-mm stage, the two intracranial carotid arteries temporarily connect through small plexiform channels; another possible etiology of the ICA fenestration is the persistence of one of these channels on the left ICA.

Fenestrations and Associated Aneurysms

There is a well-documented association between fenestrations and cerebral aneurysms, discovered through both autopsy studies and cerebral angiography. The associated aneurysms most often occur at the proximal end of the fenestration, originating at the bifurcation of the anomalous vessel into the duplicated segment, but may less commonly occur at the distal end of the fenestration. Black and Ansbacher, in a pathological study, demonstrated that a saccular aneurysm associated with a fenestration of the basilar artery may be formed secondary to a congenital defect at the site of fenestration. These authors identified a ventral defect in the muscularis layer of the vessel at each end of the fenestration, and demonstrated that the aneurysm arose at the proximal end of the fenestration. The combination of inherent structural wall weakness and local hemodynamic forces, especially at the proximal site, may predispose these sites to aneurysm formation. The association of a basilar fenestration with a saccular aneurysm has been reported in 37 cases, in which all but one were located in the proximal portion of the fenestration. In our case and the case presented by Yock, the aneurysm was located at the proximal site of the fenestration. Interestingly, there have been many case reports of cerebral artery fenestration associated with aneurysms at sites other than the fenestration. In one study, 20% of vertebral artery fenestrations were associated with aneurysms in variable locations and only one originated from the fenestration itself. The right supraclinoid ICA fenestration reported by Findlay, et al., was associated with an aneurysm located on the left ACoA, not at the site of fenestration. Whether this type of association represents concurrent congenital anomalies of embryological fusion or is purely coincidental remains a point of debate. Fenestrations of the intracranial arteries represent rare but well-recognized congenital anomalies that may be associated with aneurysms at the fenestration site or in another part of the cerebral circulation. Fenestration of the supraclinoid ICA has now been reported in three separate cases, all with associated aneurysms. This case strongly underlines the importance of considering such congenital vascular anomalies when interpreting angiographic studies.

References

Supraclinoid internal carotid artery fenestration


Manuscript received November 13, 1992.
Accepted in final form March 22, 1993.
Address reprint requests to: Eugene S. Flamm, M.D., Division of Neurosurgery, University of Pennsylvania Medical Center, 3400 Spruce Street, Philadelphia, Pennsylvania 19104.