Circulatory Variations of the Ophthalmic Artery

Robert I. Grossman,1, 2 Kenneth R. Davis,1 and Juan M. Taveras1

The collateral pathways of the ophthalmic artery are important both in occlusive carotid vascular disease as well as in interventional radiology [1-6]. We have encountered two unusual cases with intracranial abnormalities; associated with these lesions were rare circulatory variations of the ophthalmic artery. We will discuss the significance of these anomalies.

Case Reports

Case 1

A 22-year-old right-handed man had a 5 year history of progressive right-sided weakness with loss of use of hand function. There was no history of headache or seizures. Physical examination disclosed increased tone and a Babinski sign on the right side. Optic pallor was noted in the left fundus.

A bilateral carotid arteriogram and a left vertebral arteriogram revealed a large intracranial arterovenous malformation (AVM) supplied by multiple branches of the internal carotid and posterior cerebral arteries (figs. 1A and 1B). The internal carotid artery study failed to opacify any part of the ophthalmic artery. External carotid angiography demonstrated filling of the ophthalmic artery from the meningoacralairmal artery via the middle meningeal artery (figs. 1C and 1D). A choroidal blush was seen (fig. 1E). Flow proceeded retrogradely in the ophthalmic artery to supply the malformation. The arterial dynamics thus represented a steal from the ophthalmic artery circulation by the intracranial AVM.

Case 2

A 55-year-old right-handed woman complained of 2 years of progressive hearing loss and tinnitus in the right ear. Six weeks before admission the patient had developed a staggering gait. Physical examination demonstrated complete loss of hearing and caloric response in the right ear. Also noted were mild dysmetria of the right limbs and decreased facial sensation and corneal reflex on the right.

Cranial computed tomography was consistent with the diagnosis of right petrous ridge meningioma. The internal carotid arteriogram exhibited enlarged tentorial arteries and no evidence of an ophthalmic artery (fig. 2A). The external carotid artery study revealed the ophthalmic artery to fill from the meningoacralairmal artery via the anterior division of the middle meningeal artery (figs. 2B and 2C). The meningioma was partially supplied by petrosal branches arising from the posterior division of the middle meningeal artery. The middle meningeal artery contributed both significant vascularity to the tumor as well as rendering the only blood supply to the ophthalmic artery.

Discussion

It is well documented that branches of the ophthalmic artery may originate from the middle meningeal artery [7-9]. A common anastomosis occurs between the lacrimal and middle meningeal arteries through the lacrimal (Hyrll's) canal or the superior orbital fissure, and is the result of a persistent connection with a terminal branch of the supraorbital division of the stapedial artery and a retroorbital stapedial branch [10, 11]. Case 1 represents a variation of this theme. Clearly, an ophthalmic artery from the internal carotid artery is present even though it is filled solely from the middle meningeal artery. The AVM is opacified by retrograde flow from the middle meningeal artery through the meningoacralairmal artery into the proximal ophthalmic artery and supraciliary carotid artery to fill the basal ganglionic malformation. An orbital steal has been produced in which the normal blood flow pattern has been reversed. The middle meningeal and meningoacralairmal arteries have enlarged to satisfy the increased demands of the AVM. In addition, this enormous malformation has increased the velocity of blood flow through the proximal carotid artery and may generate a Venturi effect upon the ophthalmic arterial circulation [12]. We believe this patient's unilateral optic pallor may result from reduced blood flow secondary to the orbital steal. Treatment, perhaps by embolization, of the nidus of the AVM would change the circulatory dynamics and might reverse the optic pallor. This case, therefore, represents a most unusual form of collateral circulation precipitated by an AVM with resultant development of an orbital steal. It is interesting to speculate that attacks of transient monocular blindness in patients with an occluded internal carotid artery may also be caused by an ophthalmic artery steal rather than stump emboli or external carotid artery emboli.

Another situation involving retrograde arterial orbital circulatory dynamics occurs after an incomplete trapping procedure for the treatment of carotid-cavernous fistulas [13]. When the internal carotid artery proximal to the fistula is occluded (by a balloon or ligation) and the carotid artery

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1 Department of Radiology, Massachusetts General Hospital, Fruit St., Boston, MA 02114. Address reprint requests to K. R. Davis.
2 Present address: Department of Radiology, Hospital of the University of Pennsylvania, 3400 Spruce St., Philadelphia, PA 19104.
distal to the origin of the fistula is not adequately occluded, blood through the ophthalmic artery may flow retrogradely from the external carotid artery-ophthalmic artery anastomosis to fill the carotid-cavernous fistula and prevent its thrombosis. The arterial dynamics are similar to case 1 and underscore the importance in the trapping procedure of distal as well as proximal fistula occlusion.

Case 2 illustrates a very rare circulatory variation. The internal carotid artery study reveals the absence of the ophthalmic artery. The meningolacrimal artery anastomosis is the only supply to the ophthalmic artery and its branches including the ciliary arteries that produce the choroidal blush. To the best of our knowledge, this anomaly has been documented angiographically only twice before [10, 11]. The meningeal artery is providing a significant blood supply to the petrous meningeoma, which is also supplied by the tentorial artery (fig. 2A). Preoperative embolization of the tumor would be beneficial in decreasing the vascularity of this lesion. However, the major risk of embolization of the main trunk of the middle meningeal artery would be blindness [13]. Another important potential risk in proximal embolization of the middle meningeal artery is facial nerve palsy [14]. This unusual orbital collateral precluded any interventional radiographic procedure from the origin of the middle meningeal artery. Embolization, however, into the distal petrosal branches of the middle meningeal artery after subselective distal placement of a flow-guided calibrated leak balloon catheter may have been feasible.

The rich supply of anastomosis between branches of the internal and external carotid arteries around the orbit provides significant collateral flow in occlusive disease. In other disease states, the orbital circulatory dynamics are also important. Our two cases represented circulatory variations. Appreciation of an ophthalmic steal in case 1 suggested a possible cause for the patient’s optic pallor, an intriguing etiology for transient monocular blindness in the occluded
carotid artery, as well as a situation analogous to carotid-cavernous fistulas, which are only trapped proximally. Recognition of the aberrant ophthalmic arterial supply in case 2 discouraged occlusion of the middle meningeal artery from a catheter tip position at the origin of this vessel. Accurate assessment of the ophthalmic artery circulatory dynamics is critical in assessing the feasibility of interventional procedures.

REFERENCES