SHORT REPORT

Splitting and penetration of the optic nerve by an aneurysm arising from the anterior wall of internal carotid artery: case report

K Kanamaru, F Ishida, W Taki

Abstract

Aneurysms arising from the anterior wall of the internal carotid artery (ICA) are uncommon. There have not been any reports demonstrating the anatomical relation of such aneurysms to the optic nerve. An aneurysm arising from the anterior wall of the ICA splitting and penetrating the optic nerve is reported. A 73 year old woman presented with severe headache due to subarachnoid haemorrhage. She had never experienced a visual disturbance. At surgery, the aneurysm was shown to arise from the anterior wall of the left internal carotid artery and to split and penetrate the left optic nerve. The aneurysm was not related to arterial bifurcation of any branches and was safely neck clipped. Given the evidence of a split and penetration of the optic nerve, the pathogenesis of such an aneurysm may be due to the persistence of an embryonic vessel.

(*J Neurol Neurosurg Psychiatry* 2001;71:525–527)

Keywords: cerebral aneurysm, anterior wall of internal carotid artery, optic nerve, embryonic vessel

Aneurysms arising from the anterior wall of the internal carotid artery (ICA) are uncommon, reportedly comprising 0.3% to 1% of intracranial aneurysms or 0.9% to 6.5% of aneurysms of the ICA.^{1,2} The characteristic features of this particular aneurysm are not related to their arterial division and vary widely in shape.³ A postmortem study demonstrated that the internal elastic lamina and media disappeared at the border between the eccentrically sclerotic and normal carotid wall.⁴ Thus the pathogenesis of this entity is deemed to be a laceration of the carotid wall based on degeneration of the internal elastic lamina.⁴ However, how such a degenerative change occurs in the anterior wall of the ICA remains to be clarified. One possible explanation may be a remnant of the carotid-anterior cerebral artery anastomosis.⁵ Aneurysms splitting or penetrating cranial nerves are very rare.^{6–10} Only one report showed splitting of the optic

nerve due to an ICA aneurysm in which the carotid-ophthalmic aneurysm protruded upward and split the optic nerve.⁶ It was postulated that the most likely explanation was that the aneurysm arose from a vessel already penetrating the optic nerve.¹¹ In addition to the upward direction of the aneurysm, a local defect in the wall structure may explain the possible pathogenesis of the aneurysm arising from the anterior wall of the ICA. We report a case of aneurysm arising from the anterior wall of the ICA involving the optic nerve and discuss the pathogenesis of this particular condition.

Case report

A 73 year old woman presented with an abrupt loss of consciousness while taking a short bus trip. Brain CT showed a diffuse thick subarachnoid haemorrhage. Left internal carotid angiography disclosed a large aneurysm arising from the anterior wall of the ICA with superior projection (fig 1 A). The aneurysm mimicked an anterior communicating artery aneurysm. However, surgical findings confirmed a saccular aneurysm arising from the anterior wall of the left ICA splitting and penetrating the left optic nerve (fig 1 B). Clipping was performed uneventfully. Postoperative angiography showed complete neck clipping (fig 1 C). During the postoperative course, the patient became severely disabled due to florid, unrelenting vasospasm that was refractory to volume expansion and papaverine injections into the ICA.

Discussion

Aneurysms arising from the anterior wall of the ICA are usually not related to arterial division.^{3,12} Yasargil reported three cases of this unusual type of aneurysm arising from the dorsal or medial wall of the distal ICA among a series of 319 cases of ICA aneurysms.² In many patients with this particular type of aneurysm, the initial angiogram soon after subarachnoid haemorrhage shows only a small bulge from the anterior wall of the ICA.³ This bulge may progress to a saccular appearance within a few weeks.³ In the present patient, it is unlikely that the small bulge had grown sufficiently to penetrate the optic nerve in such a

Department of
Neurosurgery, Suzuka
Kaisei Hospital, Koh
112 Suzuka, Mie
513-0836, Japan
K Kanamaru

Department of
Neurosurgery, Mie
University School of
Medicine, Tsu, Mie
514-8507, Japan
F Ishida
W Taki

Correspondence to:
Dr K Kanamaru
kanamaru@h6.dion.ne.jp

Received 15 December 2000
and in revised form
20 May 2001
Accepted 3 June 2001

Figure 1 (A) Preoperative left carotid angiography showing an aneurysm on the anterior wall of the internal carotid artery (ICA) mimicking an anterior communicating artery aneurysm. (B) Surgical findings showing an aneurysm arising from anterior wall of ICA and splitting of left optic nerve. IC=internal carotid artery; An=aneurysm; II=optic nerve; dome=dome of aneurysm. Asterisks show split optic nerve. (C) Postoperative left carotid angiography showing complete obliteration of the aneurysm.

short time. Cerebral arteries rarely penetrate cranial nerves, such as optic nerves,¹³ oculomotor nerves,^{8, 11} trochlear nerves,¹¹ and abducens nerves.¹¹ In the case of the optic nerve, the optic tract was perforated by the A₁ segment.¹³ The optic chiasma was also penetrated by an anterior communicating artery aneurysm.⁷ There has been only one report that described splitting of the optic nerve by a carotid-ophthalmic artery aneurysm.⁶ The present study represents the first case of an aneurysm arising from the anterior wall of the ICA which split and penetrated the optic nerve. An anomalous artery sometimes originates from the ICA at the branching of the ophthalmic artery, passes inferiorly to the optic nerve, and ascends anteriorly to the optic chiasm to join the ACA near, or at the anterior communicating system.⁵ The anomaly might be explained by persistence to the time of full development of a vascular anastomotic loop normally present only in the embryo.⁵ Two embryonic anastomotic loops which have the necessary characteristics were suggested by Padget.¹⁴ One possibility is the transitory communication between primitive dorsal and ventral ophthalmic arteries.¹⁴ The other is a potential anastomosis between the primitive olfactory and maxillary arteries.¹⁴ An azygous ACA may arise from the origin of the ophthalmic artery and course between the two optic nerves.¹⁵

Most aneurysms originate at the bifurcation of parent arteries and become degenerative lesions due to haemodynamic stress.¹⁶ Despite the lack of substantiation, aneurysms have been alleged to arise from persistent vestigial vessels at the apex or crotch of arterial forks.¹⁷ In addition, some residual vestigial vessels from the premordial capillary plexus may be persistent without acquisition of their connective tissue sheaths.¹⁷ If aneurysms arise from such defective tissue, it is possible that sac walls might not be able to differentiate into the connective tissues of the arterial wall.¹⁷ Indeed, a particular type of aneurysm, the "blister-like" aneurysm arising from the anterior wall of the ICA, is characterised by the disappearance of the internal elastic lamina and media at the border between the eccentrically sclerotic and normal carotid wall.⁴ It remains to be elucidated whether such defects occurred due to haemodynamic stress or a congenital wall defect. Notwithstanding, the aneurysm had clearly split and penetrated the optic nerve, indicative of embryonic origin. How haemodynamic stress or degeneration could cause such an unusual anatomical situation cannot be explained.

In conclusion, split and penetration of the optic nerve by an aneurysm are rare entities. The most likely explanation is that the

aneurysm arose from a vessel already penetrating the optic nerve.

- 1 Satoh A, Nakamura H, Odaki M, *et al*. High risk aneurysm of the internal carotid artery: dorsal ICA aneurysms. *Surg Cereb Stroke* 1993;21:467–472. (In Japanese.)
- 2 Yasargil MG. *Microneurosurgery*. Vol 2. Stuttgart: Thieme, 1984:33–123.
- 3 Abe M, Tabuchi K, Yokoyama H, *et al*. Blood blister aneurysms of the internal carotid artery. *J Neurosurg* 1998;89:419–24.
- 4 Ishikawa T, Nakamura N, Houkin K, *et al*. Pathological consideration of a “blister-like” aneurysm at the superior wall of the internal carotid artery: case report. *Neurosurgery* 1997;40:403–6.
- 5 Nutik S, Dilenge D. Carotid-anterior cerebral artery anastomosis. *J Neurosurg* 1976;44:378–82.
- 6 Beatty RA. Splitting of the optic nerve by a carotid-ophthalmic artery aneurysm. *J Neurosurg* 1986;65:560–2.
- 7 Date I, Akioka T, Ohmoto T. Penetration of the optic chiasm by a ruptured anterior communicating aneurysm. Case report. *J Neurosurg* 1997;87:324–6.
- 8 Horiuchi T, Kyoshima K, Oya F, *et al*. Fenestrated oculomotor nerve caused by internal carotid-posterior communicating artery aneurysm: case report. *Neurosurgery* 1997;40:397–9.
- 9 Milliser RV, Greenberg SR, Neiman BH. Congenital or berry aneurysm in the optic nerve. *J Clin Pathol* 1968;21:335–8.
- 10 Tokarz F, Liebert W. Aneurysm situated within the optic nerve. *Neur Neurochir Pol* 1977;11:263–5.
- 11 Milisavljevic M, Marinkovic S, Lolic-Draganic, *et al*. Oculomotor, trochlear, and abducens nerves penetrated by cerebral vessels. *Arch Neurol* 1986;43:58–61.
- 12 Nakagawa F, Kobayashi S, Takemae T, *et al*. Aneurysms protruding from the dorsal wall of the internal carotid artery. *J Neurosurg* 1986;65:303–8.
- 13 Maurer J, Maurer E, Perneczky A. Surgically verified variations in the A₁ segment of the anterior cerebral artery. *J Neurosurg* 1991;75:950–3.
- 14 Padget DH. The development of the cranial arteries in the human embryo. *Contributions to Embryology* 1948;32:207–61.
- 15 Senter HJ, Miller DJ. Interoptic course of the anterior cerebral artery associated with anterior cerebral artery aneurysm. *J Neurosurg* 1982;56:302–4.
- 16 Stehbens WE. Etiology of intracranial berry aneurysms. *J Neurosurg* 1989;70:823–31.
- 17 Drennan AM. Discussion. *Edinburgh Medical Journal* 1933;40:234–5.