Delayed Post-traumatic Pseudoaneurysmal Formation of the Intracranial Ophthalmic Artery After Closed Head Injury

—Case Report—

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Abstract

A 42-year-old male presented with a rare case of delayed aneurysmal formation of the intracranial ophthalmic artery after closed head injury manifesting as subarachnoid hemorrhage. Initial magnetic resonance angiography revealed no aneurysmal formation, but angiography 7 days after the injury demonstrated an intracranial ophthalmic artery aneurysm. Follow-up computed tomography angiography demonstrated enlargement of the aneurysm. The aneurysm was successfully treated by surgical resection. Histological examination revealed that the aneurysm was a pseudoaneurysm. Traumatic intracranial aneurysm (TICA) is rare and usually occurs in the peripheral arteries of the cerebral circulation or the basal portion of the internal carotid artery. The present case shows that failure to demonstrate an aneurysm on the initial angiography in the acute stage does not exclude the presence of traumatic aneurysm. This case clearly shows the time course of development of a TICA of the ophthalmic artery after closed head injury.

Key words: traumatic intracranial aneurysm, ophthalmic artery, pseudoaneurysm, closed head injury, angiography

Introduction

Traumatic intracranial aneurysms (TICAs) are distinctly uncommon and represent fewer than 1% of all intracranial aneurysms.1,10 TICAs have been reported following both blunt and penetrating head injury. Blunt injury usually causes trauma to either the peripheral arteries of the cerebral circulation or the internal carotid artery (ICA). We describe a rare case of delayed formation of pseudoaneurysm of the intracranial ophthalmic artery after closed head injury.

Case Report

A 42-year-old male with no significant past medical history was crushed against a traffic signal while driving a motorcycle wearing a loosely-fastened half helmet. He suffered a strong blow to the right parietal region of his head. Immediately after the injury, he lost consciousness and was taken to our hospital. On arrival, he did not open his eyes to pain, made no verbal response, but withdrew from pain and was assessed as Glasgow Coma Scale score 6. Neurological examination revealed mydriasis and bilateral loss of light reflex, although extraocular movements could not be evaluated. Brain stem reflexes were intact and motor paresis was not observed.

Initial computed tomography (CT) demonstrated extensive subarachnoid hemorrhage (SAH), predominantly within the basal cisterns around the brainstem and filling the fourth ventricle (Fig. 1A), and a linear skull fracture in the right parietal bone. There was no evidence of fractures in the skull base including the optic canal. Subsequently, magnetic resonance angiography was performed to find the cause of the SAH, but revealed neither aneurysmal formations nor any other vascular abnormalities (Fig. 1B). Two hours after the injury, he suddenly exhibited left mild hemiparesis. Immediate follow-up CT demonstrated formation of an epidural hematoma located directly below the linear skull fracture in the right parietal bone (Fig. 1C). Emergent craniotomy was performed, the hematoma was successfully removed, and the left hemiparesis disappeared after the operation.

Over several days, the patient gradually returned to normal consciousness, although he exhibited mild dementia and left total blindness. Seven days after the injury, three-dimensional digital subtraction angiography (3D-DSA) was performed to investigate the possible cause of SAH. 3D-DSA demonstrated an ophthalmic artery aneurysm located directly below the linear skull fracture in the right parietal bone (Fig. 1D).
Fig. 1  A: Computed tomography (CT) scan on admission showing extensive subarachnoid hemorrhage (SAH) predominantly located within the basal cistern and intraventricular hematoma in the fourth ventricle.  B: Magnetic resonance angiogram on admission revealing no aneurysmal formations or any other vascular abnormalities of the cerebral arteries including the ophthalmic artery (arrowheads).  C: Follow-up CT scan 2 hours after the injury showing epidural hematoma formation in the right parietal region.

Fig. 2  A, B: Two-dimensional digital subtraction angiography (DSA) image (A) and three-dimensional DSA (3D-DSA) rendering image (B) of the left internal carotid artery on day 7 after the injury showing an ophthalmic artery aneurysm located 2 mm distal from the origin of the ophthalmic artery.  C: Follow-up three-dimensional computed tomography angiogram on day 19 after the injury showing no change in aneurysm size compared to day 7.  D: Second follow-up 3D-DSA image on day 34 after injury showing an increase in aneurysm size from 4 mm to 8 mm in diameter.

Fig. 3  Photomicrograph of the aneurysm wall showing blood clot and collagen fiber, which formed a poorly defined sac, with no wall structure including elastic tissue or adventitia. Arrowhead indicates lumen.  Hematoxylin and eosin stain, original magnification × 100.

cated 2 mm distal from the bifurcation of the ICA and the ophthalmic artery (Fig. 2A, B). Three-dimensional CT (3D-CT) angiography was performed every other week to follow up the size of the aneurysm. The second follow-up 3D-CT angiography demonstrated enlargement of the aneurysm from 4 mm to 8 mm in diameter (Fig. 2C, D).

The aneurysm was treated through the left pterional approach. The anterior clinoid process was removed through the extradural approach and the falciform ligament was cut to provide mobility of the optic nerve. An extremely thin and reddish-walled aneurysm was found under the optic nerve, and the proximal neck of the ophthalmic artery aneurysm was identified 2 mm distal from the origin of the ophthalmic artery. After clamping the origin of the ophthalmic artery, the aneurysm was resected from the ophthalmic artery as a whole mass. The ophthalmic artery was sacrificed because the patient had already developed left total blindness on admission. Histological examination of the surgical specimen revealed blood clot and collagen fiber, which formed a poorly defined sac (Fig. 3). No wall structure including the elastic tissue or adventitia was found in the specimen (Fig. 3). These histological findings resulted in a diagnosis of "pseudo"-aneurysm. He was discharged on the 37th postoperative day with no neurological dysfunction except for mild dementia and left total blindness.

Discussion

This rare case of the pseudoaneurysmal formation of ophthalmic artery resulted from a closed head injury. TICAs associated with closed head injury usually occur in the ICA or distal peripheral branches of the cerebral artery.3,5) Review of 171 cases of the TICAs to investigate the location found only two TICAs (1.2%) of the ophthalmic artery.9) Only five cases of traumatic ophthalmic artery

Neurol Med Chir (Tokyo) 52, January, 2012
aneurysm have been reported excluding those of the intraorbital ophthalmic artery.\textsuperscript{5-7,12,14} Four of these five cases were supraclinoid ICA aneurysms located at the bifurcation of the ICA and the ophthalmic artery, and only one case was located at the peripheral portion of the ophthalmic artery,\textsuperscript{11} as seen with our case.

In closed head injury, the anatomical location of the TICAs reflects the underlying mechanism of the injury. For example, TICAs result from blunt injury to the ICA caused by the supraclinoid process, to the pericallosal artery by the edge of the falx, or to the middle cerebral artery by the sphenoid ridge.\textsuperscript{10} Moreover, intraclinoid ICA and basilar artery aneurysms are commonly associated with skull base fractures.\textsuperscript{9} The possible mechanism for the formation of the traumatic ophthalmic artery aneurysm was not fully understood. After originating from the ICA, the ophthalmic artery runs under the optic nerve and penetrates the dural sheath of the optic nerve in the floor of the optic canal.\textsuperscript{9} In our case, the aneurysm occurred not at the bifurcation of the ICA and the ophthalmic artery, but at the peripheral portion of the ophthalmic artery located adjacent to the dural penetration point. Additionally, there was no evidence of skull base fracture around the optic canal in our case. Therefore, we considered that a sharp blow to the head might have caused stretching and tearing of the ophthalmic artery at the dural penetration point, leading to SAH. We suggest that a minor tear in the arterial wall, which was sealed off by blood clots, recanalized later and formed a false lumen,\textsuperscript{21} which gradually developed over a week.

As shown in our case, the initial angiography does not always demonstrate the aneurysm. A total of 17 of 171 cases (9.9\%) showed false negative angiographic demonstration of the aneurysm on the day of trauma.\textsuperscript{10} Therefore, follow-up angiography should be obtained if the initial study is negative in a patient with severe head trauma. TICAs occasionally regress in size, or spontaneously disappear,\textsuperscript{4,9,10} but have a high incidence of rupture.\textsuperscript{1,2} Therefore, surgery or endovascular treatment is necessary as soon as practicable after the diagnosis of TICA. In our case, the aneurysm originated at the peripheral portion of the ophthalmic artery near the dural penetration point, and the patient had already lost sight in his left eye. Therefore, this patient might have been a good candidate for endovascular treatment including parent artery occlusion as previously reported.\textsuperscript{2,7}

The clinical course of our patient illustrates a discrepancy in the functional status between admission and discharge. Initial Glasgow Coma Scale score of the patient was 6 with mydriasis and bilateral loss of light reflex, whereas he was discharged with no neurological dysfunc-

tion except for mild dementia and left total blindness. In patients with severe head injury, acute pupillary dilation including loss of pupillary reflex is associated with decreased brain stem blood flow and is sometimes reversible.\textsuperscript{11} The discrepancy may also be caused by extensive SAH on admission. About 20\% of severe SAH patients with World Federation of Neurosurgical Societies (WFNS) grades IV and V on admission showed improvement in WFNS grade preoperatively.\textsuperscript{13} However, the exact reason for such a discrepancy remains to be elucidated.

The present rare case of the traumatic aneurysm of ophthalmic artery shows that failure to demonstrate an aneurysm on the initial angiography in the acute stage does not exclude the presence of a traumatic aneurysm. This case clearly illustrates the time course of the development of traumatic pseudoaneurysmal formation of the ophthalmic artery after closed head injury.

\textbf{References}


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\textit{Neurol Med Chir (Tokyo)} 52, January, 2012