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High Incidence of Arterial Dissection Associated With Left Vertebral Artery of Aortic Origin

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Abstract

The incidences of arterial dissection of the vertebral artery (VA) of aortic origin and VA of subclavian artery origin were determined. The origins of the left and right VAs were confirmed by angiography in 860 and 717 patients, respectively. Left VA of aortic origin was found in 21 patients (6 females and 15 males) but no right VA of aortic origin was found. Left VA of left subclavian artery origin was found in 837 patients and right VA of right subclavian artery origin in 717 patients. Arterial dissection of the VA occurred in 17 patients (6 females and 11 males), four patients with left VA of aortic origin, seven with left VA of left subclavian artery origin, four with right VA of right subclavian artery origin, and two with bilateral VAs of subclavian artery origin. Left VA of aortic origin (4 of 21 patients) was associated with a significantly higher incidence of VA dissection than left VA of left subclavian artery origin and right VA of right subclavian artery origin ($p < 0.001$). Left VA of aortic origin is associated with a predilection for VA dissection in comparison to VA of subclavian artery origin.

Key words: angiography, arterial dissection, vertebral artery

Introduction

Spontaneous arterial dissection of the vertebral artery (VA) has been increasingly recognized in recent years.[3,7,15,18] Extracranial VA dissection causes brain ischemia, and intracranial dissection causes either subarachnoid hemorrhage or brain ischemia. Vascular anomalies of the VA, including fenestration, duplication, abnormal course, or abnormal origin, are occasionally associated with intracranial vascular lesions, such as cerebral aneurysms, arteriovenous malformation, arterial dissection, and moyamoya disease.[5,8,10,12,13,17] We examined the incidence of arterial dissection of the VA and its relationship to the origin of the VA from either the aorta or subclavian artery.

Materials and Methods

This study retrospectively reviewed 1567 cerebral catheter angiography procedures performed in 1109 patients for many reasons over the past 5 years. Aortography, subclavian or innominate arteriography, or vertebral arteriography was performed in 908 patients. The origins of the left and right VAs were confirmed in 860 and 717 patients, respectively. The angiograms of these patients were examined to evaluate the relationship between arterial dissection of the intracranial and/or extracranial VAs and the origin of the VA from the aorta or subclavian artery. The angiographic definition of arterial dissection includes stenosis (string sign), fusiform dilatation, pearl and string sign, occlusion, irregularity of the arterial wall, double lumen sign, stagnation of the contrast material, and chronological change of these signs and/or findings.

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Results

Left VA of aortic origin occurred in 21 patients (6 females and 15 males), an incidence of 2.4%. No right VA of aortic origin was found. Left VA of left subclavian artery origin was found in 837 patients and right VA of right subclavian artery origin in 717 patients. Two patients had dual origin of the left VA, with one leg originating from the aorta and another leg from the left subclavian artery.[11] One patient had dual origin of the right VA, with both legs originating from the right subclavian artery.

Arterial dissection of the VA was detected in 17 patients (6 females and 11 males), an incidence of 1.9%. Arterial dissection occurred on the left side in

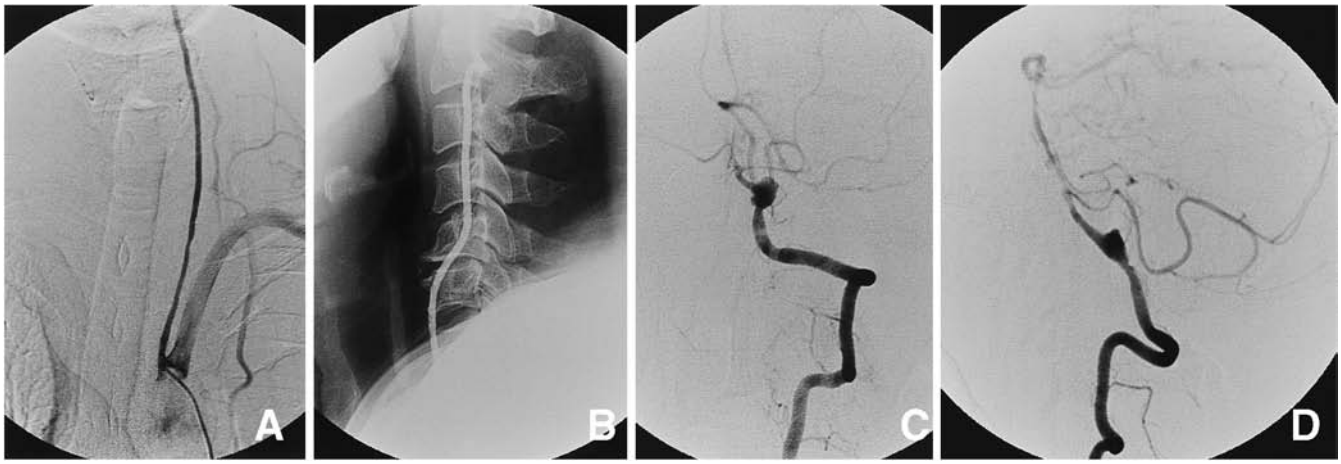

Fig. 1 Case 1. Selective angiograms of the left vertebral artery of aortic origin (A: frontal view, B: lateral view) showing the left vertebral artery entering the transverse foramen at C-5. Intracranial left vertebral angiograms (C: frontal view, D: lateral view) showing string and pearl sign, indicating vertebral dissection.

11, on the right side in four, and on both sides in two patients. Intracranial dissection was present in 13 patients. Two patients had extracranial dissection and another two patients had both intracranial and extracranial dissection. Nine patients had subarachnoid hemorrhage, seven patients had brain ischemia, and one was asymptomatic.

Four of the 21 patients (19.0%) with left VA of aortic origin (excluding two patients with dual origin of the VA) developed arterial dissection of the left VA. Nine of the 837 patients with left VA of left subclavian artery origin (1.1%) developed arterial dissection of the left VA. Six of the 717 patients (0.84%) with the right VA of right subclavian artery origin developed arterial dissection of the right VA. Left VA of aortic origin was associated with a significantly higher incidence of arterial dissection of its own vessel than left VA of left subclavian artery origin ($p < 0.001$) and right VA of right subclavian artery origin ($p < 0.001$).

Illustrated Cases

Case 1: A 53-year-old male developed sudden occipitalgia without neurological deficits. Low-grade fever continued until the patient came to our hospital 10 days later. On admission, the patient was alert without focal deficits except for stiff neck. Computed tomography (CT) showed no abnormalities, but cerebrospinal fluid (CSF) examination revealed xanthochromic CSF. Cerebral angiography revealed arterial dissection of the left VA, which originated directly from the aorta and entered the fifth transverse foramen (Fig. 1). The right VA originated from the right subclavian artery and entered the sixth transverse foramen. The left VA dissection was trapped surgically without sequelae.

Case 2: A 62-year-old male suddenly developed left occipitalgia and then consciousness disturbance. On admission, the patient was drowsy, but responded correctly. He had left Horner's sign, mild left cerebellar sign, and left facial and right hemicorporeal hypalgesia without motor weakness, which was consistent with a diagnosis of left lateral medullary syndrome. CT showed no abnormalities. Cerebral angiography revealed stenotic change (string sign) of the intracranial left VA, from which the left posterior inferior cerebellar artery (PICA) originated. The left VA originated directly from the aorta and entered the fifth transverse foramen, and the right VA originated from the right subclavian artery and entered the sixth transverse foramen (Fig. 2). This patient was treated conservatively. Follow-up angiography on day 15 revealed occlusion of the left VA distal to the left PICA. The patient's consciousness soon recovered completely, but moderate cerebellar sign and sensory deficits remained.

Discussion

Arterial dissection of the VA occurred more frequently on the left than on the right in our series (11 on the left, 4 on the right, and two bilaterally). Previous reports have not found any apparent predilection in the laterality of intracranial VA dissection: 14 left, 10 right[18]; 14 left, 17 right, two bilateral[15]; 124

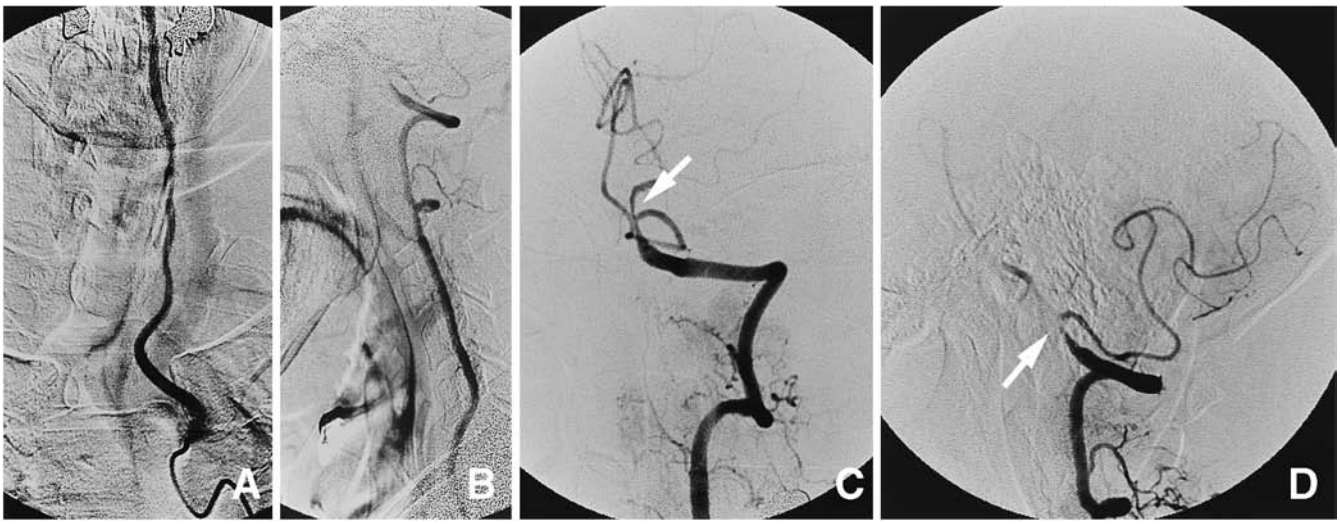

Fig. 2 Case 2. Subselective angiograms of the left vertebral artery of aortic origin (A: frontal view, B: lateral view) showing the left vertebral artery entering the transverse foramen at C-5. Intracranial left vertebral angiograms (C: frontal view, D: lateral view) showing the stenotic lesion (*arrow*) at the origin of the posterior inferior cerebellar artery.

left, 137 right[19]; or in extracranial VA dissection: six left, four right, five bilateral.[3] However, intracranial VA dissection causing hemorrhage occurred more frequently on the right than on the left (left 62, right 98), and dissection causing ischemia occurred more frequently on the left than on the right (left 62, right 39) when examined separately.[19]

The reasons for the high incidence of arterial dissection associated with VA of aortic origin remain to be elucidated, although statistical chance is possible due to small sample size of the patients with arterial dissection of the VA of aortic origin. However, there could be two anatomical explanations: congenital structural defects of arterial wall and alteration of cerebral hemodynamics. Congenital medial defects of arterial wall occur at the fenestration of the basilar artery.[2,4] Such medial defect as well as hemodynamic stress and turbulent flow at the fenestration may contribute to the development of saccular aneurysm at this location.[6] Embryonic variations of the cerebral arteries, such as duplication of the middle cerebral artery and accessory middle cerebral artery, are often associated with cerebral aneurysms, suggesting a congenital medial defect of the cerebral arteries.[9] Similarly, arterial dissection of the VA of aortic origin could be attributable to the structural defects of the VA. Structural defect of the VA, although not proved in the cases of VA of aortic origin, could cause arterial dissection of the VA, usually in the intracranial V_4 portions.

The VA is formed in the embryo from the longitudinal vascular anastomoses between the proatlantal segmental arteries and the seven cervical segmental arteries, which originate from the paired dorsal aortas and supply the spinal cord and eight cervical nerves.[14,16] The first six segmental arteries (the first being the proatlantal segmental arteries) involute and the seventh segmental arteries, i.e., the sixth cervical segmental arteries, usually become the proximal portions of the VAs and subclavian arteries.[14] Normally, the left VA originates from the left subclavian artery and enters the sixth transverse foramen. However, the left VA occasionally originates directly from the aorta with an incidence of 2.4–5.8%.[7] In this situation, the VA commonly enters the fifth transverse foramen.

Anomalous origin of the VA causes alteration of the cerebral hemodynamics.[1] Shear stress may be larger in the VA of aortic origin than in the VA of subclavian artery origin, possibly due to the anatomical differences. The VA of aortic origin may receive direct arterial pulsatile flow whereas the VA of subclavian artery origin may receive damped blood flow due to the presence of the proximal subclavian artery. Different levels of entry of the VA to the transverse foramen may also contribute to differences in hemodynamics. The VA of aortic origin usually enters at the C5-6 intervertebral level whereas the VA of subclavian artery origin enters at the C6-7 intervertebral level. This higher entry of the VA to the transverse foramen may cause larger shear stress in the distal portion of the VA.

Left VA of aortic origin is associated with a predilection for VA dissection in comparison to left

VA of subclavian artery origin.

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Commentary

The authors have provided a concise and well written article documenting some interesting observations on vertebral artery dissection from their analysis of 860 angiograms on 717 patients. In many instances, the etiology of vertebral artery dissection remains enigmatic. The authors have demonstrated that an aortic origin of the left vertebral artery, although uncommon, is associated with a significantly higher incidence of vertebral artery dissection than a subclavian origin of the vertebral artery. Although this observation could be entirely coincidental, the markedly increased incidence of vertebral artery dissection with aortic as opposed to subclavian origin in this study provides compelling evidence that there may be a hemodynamic or embryologic relationship between an aortic origin of the vertebral artery and predisposition to dissection. This outstanding study should stimulate further investigation of this potential association.

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This study examined the incidence of a direct origin of the left vertebral artery (VA) from the aorta, and the relative incidence of VA dissection, in a large number of patients with vertebral angiograms accumulated over five years. The interesting finding made was that there was a 19% incidence of VA dissection in the 21

patients with left VA aortic origin, compared with around 1% where the left or right VA arose from the subclavian. Although the numbers were small, the difference was highly significant and considerable, with an odds ratio of 21.7 (95% confidence interval 6.1–77.3). Possible explanations for this difference are well discussed, including possible structural anomalies in the wall of the vessel, known to be associated with other congenital vascular anomalies, and greater haemodynamic stress in the artery arising directly from the aorta with its higher pressure and pulsation. Extensions of this work from other large series would be interesting, including whether there is any association with aneurysm formation or other vessel abnormalities.

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Komiyama et al. attempted to correlate the incidence of arterial dissection of the vertebral artery (VA) and its relationship to the origin of the VA in 1,577 patients with vertebral angiography. This interesting study suggested that left VA of aortic origin was associated with a predilection for VA dissection (4 of 21 patients) in comparison to left VA of left subclavian artery origin (7 of 837 patients), and right VA of right subclavian artery origin (4 of 717 patients). Although statistical chance is possible due to the small sample size of the patients with arterial dissection of the VA of aortic origin (4 patients), the authors tried to interpret the finding as a result of altered cerebral hemodynamics and shear stress caused by an anomalous origin of the VA. As the patients with dissecting aneurysms were characteristically relatively young males, and a right-sided dominance was reported,[1,2] further accumulation of such cases would be necessary to elucidate this unique VA lesion.

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