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Dual Origin of the Vertebral Artery

—Case Report—

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Abstract

A 27-year-old female presented with dual origin of the left vertebral artery. Twenty-six cases of this rare congenital vascular anomaly have been reported. In general, the medial leg of the dual origin of the vertebral artery enters a higher transverse foramen (usually the fifth or less frequently the fourth) than the lateral leg, which usually enters the sixth. Exceptions to this rule occur when the medial and lateral legs of the right vertebral artery enter the right seventh and sixth transverse foramina, respectively. This congenital vascular anomaly has diagnostic and therapeutic implications in any intervention involving the proximal vertebral artery.

Key words: congenital vascular anomaly, dual origin, embryology, vertebral artery

Introduction

The vertebral arteries (VAs) are formed in the embryo of the longitudinal vascular anastomoses between the proatlantal intersegmental arteries and seven cervical intersegmental arteries, which originate from the paired dorsal aortas and supply the spinal cord and eight cervical nerves.[17,20] The first six intersegmental arteries (the first being the proatlantal intersegmental arteries) involute and the seventh intersegmental arteries, i.e., the sixth cervical intersegmental arteries, usually become the proximal portions of the VAs and subclavian arteries.[17] Anomalous remnants or anomalous involution of these embryological intersegmental arteries may lead to anomalous origin or dual origin of the VAs. Dual origin of the VA is a rare anomaly, first described in 1844.[21] In addition to the anatomical cases reported in 1911,[9] there have been 26 cases of dual origin of the VA.[2-7,9-19,22-26] We present a patient with this vascular anomaly, and discuss the diagnostic and therapeutic implications.

Case Report

A 27-year-old female underwent cerebral angiography as a preoperative examination for a large left acoustic neurinoma. Her past and family histories were unremarkable. Digital subtraction angiography by the Seldinger method revealed the dual origin of the left VA as well as mass sign and tumor staining in the left cerebellopontine angle. There were no other vascular anomalies. The right VA was larger in diameter than the distal portion of the left VA. The proximal portions of the left VA were composed of two arteries: an artery directly originating from the aorta (medial leg) and an artery originating from the left subclavian artery (lateral leg) (Fig. 1). The medial leg was larger in diameter than the lateral leg. The medial leg entered the fourth transverse foramen, where it connected to the lateral leg. The lateral leg entered the sixth transverse foramen, where it gave rise to the radiculomedullary artery and the anterior spinal artery. The lateral leg did not have any apparent branch to the spinal cord. The dual origin of the left VA in this patient was incidental.

Discussion

Dual origin of the VAs has been described in 26 cases (Table 1).[2-7,9-19,22-26] We excluded the anatomical cases cited in 1911[9] because these cases were reported in the nineteenth century and the references are not available now, but some of them are worthwhile mentioning in brief. In addition to the anatomical variations listed in Table 1, some cadavers had other patterns of pleural origin of the

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Fig. 1 Selective angiograms, anteroposterior view (A) and lateral view (B), of the medial leg of the dual origin of the left vertebral artery, showing streaming and reflux of the contrast material to the lateral leg at C-4 level (*arrow*). Left subclavian angiograms, anteroposterior view (C) and lateral view (D), showing the lateral leg of the left vertebral artery (*arrowheads*), which enters the C-6 transverse foramen. The anterior spinal artery (*arrow*) is fed by the radiculomedullary artery at the C-6 level from the lateral leg of the dual origin of the vertebral artery.

VAs: two left VAs originating from a stem artery of aortic origin,[1] and two left VAs originating from a stem artery of aortic origin and the third VA originating from the left subclavian artery (triple left VAs).[9]

Dual origin of the VA was observed on the right side in 12 cases and on the left side in 14 cases. Ten

Table 1 Dual origin of the vertebral arteries (VAs)

Case No.	Author (Year)	Age/ Sex	Laterality	Medial leg (1)	Entrance* (1)	Lateral leg (2)	Entrance* (2)	Union level**	Size***	Dominance#	Disease/symptom	Remarks
1	Neuberger (1912)[16]	?/M	rt	subclavian	3	subclavian	6	3	1>2	?	cadaver	
2	Kiss (1968)[10]	46/M	rt	brachiocephalic	?	subclavian	?	5	1>2	?	paresthesia of the limb	lt CCA originating from the brachiocephalic artery, aortic origin of the lt VA
3	Newton and Mani (1974)[17]	?	rt	subclavian	?	subclavian	?	4-5	1>2	?	?	
4	Babin and Haller (1974)[2]	18/F	rt	subclavian	7	subclavian	6	6	1>2	?	cervicooccipital pain	incomplete block vertebra (C3–4)
5	Rath and Prakash (1984)[22]	?/M	rt	subclavian	4	subclavian	6	3-4	1>2	?	cadaver	
6	Lasjaunias and Berenstein (1987)[14]	?	rt	aorta	4	subclavian	below 4	4	1>2	?	?	
7	Harada et al. (1987)[6]	70/F	rt	subclavian	?	subclavian	?	4	1=2	rt	dizziness	lt hypoplastic VA
8	Hashimoto et al. (1987)[7]	67/M	rt	subclavian	5	subclavian	6	5	1<2	rt=lt	dizziness	

Contd.

Table 1, contd.

Case No.	Author (Year)	Age/ Sex	Later-ality	Medial leg (1)	En-trance* (1)	Lateral leg (2)	En-trance* (2)	Union level**	Size***	Domi-nance#	Disease/symptom	Remarks
9	Çavdar and Arisan (1989)[4]	54/F	rt	subclavian	7	subclavian	6	6	1>2	?	cadaver	lt VA originating from the aorta entering the C-5 transverse foramen
10	Brugières et al. (1990)[3]	40/F	rt	subclavian	4	subclavian	6	4	1>2	?	chondrosarcoma of the rib	anterior spinal artery originating from the lateral leg
11	Takasato et al. (1992)[26]	37/M	rt	subclavian	3	subclavian	5	3-4	1>2	rt>lt	pontine infarction	rudimentary and accessory lt VAs
12	Nogueira et al. (1997)[18]	27/M	rt	subclavian	7?	subclavian	6?	6	1=2	?	carvical trauma	suspected VA dissection
13	Kemmetmüller (1911)[9]	34/M	lt	aorta	5	aorta	6	5-6	1<2	rt<lt?	cadaver	
14	Koo and Sakai (1966)[11]	74/F	lt	aorta	5	subclavian	6	3-4	1>2	?	heart disease/ cadaver	
15	Kowada et al. (1972)[12]	19/F	lt	aorta?	5	subclavian	below 5	5	1<2	?	post-traumatic epilepsy	fenestration of the lt VA at the atlantoaxial Junction
16	Suzuki et al. (1978)[25]	66/M	lt	aorta	5	subclavian	6	5	1>2	?	aortic aneurysm	
17	Rieger and Huber (1983)[23]	43/?	lt	aorta	4	subclavian	below 4	4	1>2	rt>lt?	cerebrovascular insufficiency	aneurysm of the rt extracranial ICA
18	Eisenberg et al. (1986)[5]	20/M	lt	aorta	5	subclavian	6	5	1>2	?	cerebral aneurysm	
19		26/M	lt	aorta	?	subclavian	?	5	1<2	?	cervical gunshot wound	
20	Hashimoto et al. (1987)[7]	73/M	lt	aorta	5	subclavian	6	5	1=2	rt>lt	dizziness	fenestration of the lt VA at C-1 and C-2
21	Mashiyama and Watanabe (1989)[15]	59/F	lt	aorta	5	subclavian	below 5	5	1<2	rt>lt	brain tumor	
22	Kuwahara et al. (1989)[13]	12/M	lt	aorta	5	subclavian	below 5	5	1=2	rt>lt	moyamoya disease	
23	Onizuka et al. (1991)[19]	19/F	lt	aorta	?	subclavian	?	4	1<2	rt>lt	epilepsy	rt proatlantal artery, rt aplastic VA
24	Sugita et al. (1995)[24]	57/M	lt	aorta	?	subclavian	?	4	1=2	?	lt ICPC aneurysm	
25	Nogueira et al. (1997)[18]	39/F	lt	aorta	5	subclavian	below 5	5-6	1=2	?	cervical trauma	suspected VA dissection
26	Present case	27/F	lt	aorta	4	subclavian	6	4-5	1>2	rt>lt	acoustic neurinoma	

*Level of the transverse foramen at which the leg of the dual origin of the VA enters. **Level at which two legs connect together. ***Relative size of the medial (1) and lateral (2) legs. #Dominance between the right and left VAs. brachiocephalic: brachiocephalic artery, CCA: common carotid artery, ICA: internal carotid artery, ICPC: internal carotid-posterior communicating artery, subclavian: subclavian artery.

patients were female and 13 were male. The union of the medial and lateral legs was located at the C3-4 intervertebral space or C-3 dermatome in four cases, at the C4-5 intervertebral space or C-4 dermatome in eight, at the C5-6 intervertebral space or C-5 dermatome in 11, and at the C6-7 intervertebral space or C-6 dermatome in three. The right medial leg entered the third transverse foramen in two cases, the fourth in three, the fifth in one, and seventh in three, whereas the right lateral leg entered the fifth in one and sixth in seven. The left medial leg entered the fourth transverse foramen in two cases and the fifth in nine, whereas the left lateral leg entered the sixth in six cases. The right proximal legs originated from the brachiocephalic artery and subclavian artery in one case,[10] from the aorta and subclavian artery in one,[14] and both from the subclavian artery in 10. The left proximal legs originated from a stem artery which branched off from the aorta in one case,[9] and from the aorta and the subclavian artery in 13. The right medial leg was larger than the right lateral leg in nine cases, equal in two, and smaller in one. The left medial leg was larger than the left lateral leg in five cases, equal in four, and smaller in five.

In general, the medial leg entered a higher transverse foramen (usually the fifth or less frequently the fourth) than the lateral leg, which usually entered the sixth. Exceptions to this rule occurred in three cases, in which the medial and lateral legs entered the right seventh and sixth transverse foramina, respectively.[2,4,18] In no case did the left VA enter the seventh transverse foramen or the right VA originate from the aorta distal to the left subclavian artery. Although dual origin of the VA seems to be asymptomatic, associated diseases were reported as cervical trauma in three cases, cerebral aneurysms in two, brain tumor in two, epilepsy in two, and moyamoya disease in one.

VAs are formed in the embryo of the longitudinal anastomoses between the eight embryological intersegmental arteries.[17,20] The first intersegmental arteries can be called the proatlantal intersegmental arteries or suboccipital intersegmental arteries.[20] The persistent portions of the embryological intersegmental arteries form the proximal portion of the subclavian arteries and VAs, and are usually the seventh intersegmental arteries, i.e., the sixth cervical intersegmental arteries. 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%.[8] In this situation, the VA commonly enters the fifth transverse foramen.

Dual origin of the VA is extremely rare. Although the persistent proatlantal intersegmental arteries

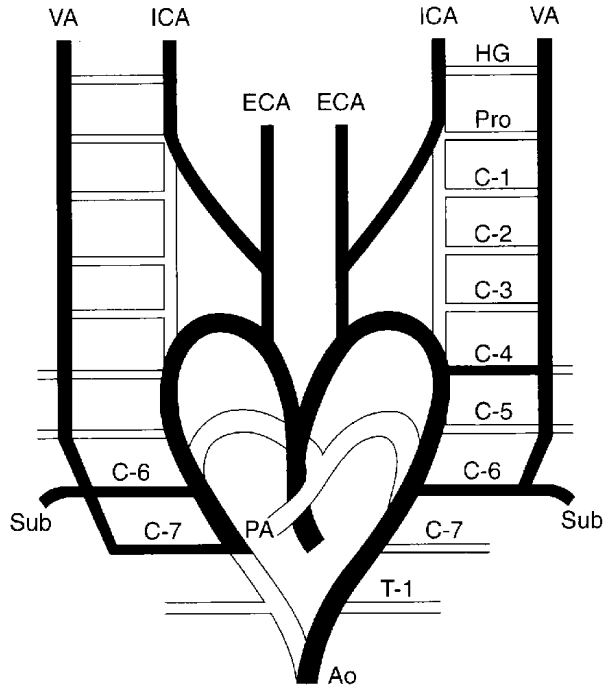

Fig. 2 Schematic drawing of the dual origin of the vertebral arteries (VA). Modification from Kemmetmüller's schema.[9] The vascular anatomy of our patient is shown on the left side. The medial leg enters the fourth transverse foramen and the lateral leg enters the sixth. On the right side, the medial leg enters the seventh transverse foramen and the lateral leg enters the sixth. Ao: aorta, C-1: first cervical intersegmental artery, ECA: external carotid artery, HG: hypoglossal artery, ICA: internal carotid artery, PA: pulmonary artery, Pro: proatlantal artery, Sub: subclavian artery, T-1: first thoracic intersegmental artery.

can be regarded as dual origin of the VAs in a broad sense, we have considered only the proximal dual origin of the VAs. When one leg of the dual origin of the VA is hypoplastic and does not connect with its counterpart, this vessel may remain as a 'rudimentary' VA. Persistence of the left fourth or fifth (or less frequently third) cervical intersegmental arteries may result in aortic origin or dual origin of the left VA (Fig. 2). The left fourth and fifth intersegmental arteries rarely branch off from a stem artery, which originates from the aorta between the left common carotid artery and left subclavian artery.[1,9] Dual origin of the VA originating from the right subclavian or brachiocephalic artery occurs due to persistence of the right fourth or fifth (or less frequently third) cervical intersegmental arteries.

Only when the right seventh intersegmental artery does not involute and the sixth intersegmental artery becomes the subclavian artery as usual, the medial leg is formed of the seventh intersegmental artery probably due to a large amount of blood flow to the sixth intersegmental artery (Fig. 2). Aortic origin of the right VA may occur in two extremely rare situations: when the right seventh cervical intersegmental artery originates from the descending aorta distal to the left subclavian artery and enters the right seventh transverse foramen; and when the right fourth or fifth cervical intersegmental artery originates from the ascending aorta and the right subclavian artery originates from the descending aorta distal to the left subclavian artery.

Selective catheter angiography using the Seldinger method may overlook dual origin of the VA. Aortography may also fail to detect it due to poor visualization of the small vessels. When only one leg of the dual origin of the VA is visualized, there is a possibility of misdiagnosis of hypoplasia of the VA. Dual origin of the VA should be suspected when streaming of contrast medium or filling defect of the vessel, irregularity of the lumen, or abrupt change in the diameter of the VA is observed[5] or when dissection of the VA is suspected at the level of the C4-6.[18] To visualize the dual origin of the VA, pressure injection of the contrast material to one leg may result in reflux to another leg.[5] Right brachiocephalic injection may visualize right-sided dual origin of the VA when the origins of both legs are located at the subclavian and/or brachiocephalic arteries. Due to technical difficulty or ignorance of this congenital vascular anomaly, many cases with dual origin of the VA may be overlooked and this anomaly could be more common than expected.[5]

Dual origin of the VA usually has no clinical expression,[14,26] as in our patient. However, on angiography it may mimic arterial dissection in cases of the cervical trauma, especially in association with fracture of the vertebral bone.[18] This anomaly may be encountered unexpectedly in the lower cervical spinal surgery because the entry of the medial leg to the transverse foramen is generally higher than usual. As shown in our case, the anterior spinal artery may be supplied by one of the legs. Although kinking at the proximal portions of two legs was surgically corrected in a patient with dizziness,[6] the pathogenesis of dizziness did not seem to be related to the dual origin of the VA, but to the kinking. Proximal leg originating directly from the aorta could be a collateral to the distal VA when the proximal segment of the subclavian artery[25] or the VA originating from the subclavian artery has stenosis.[5] Thus, knowledge of the dual origin of the VA is important in planning of any intervention involving the proximal VA.

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