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ANATOMIC VARIATIONS

Duplicate origin of the right vertebral artery in which both channels arose from the extreme proximal right subclavian artery: a case report

Akira Uchino[1] · **Hiroki Kurita**[2]

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Abstract Rarely, two channels of the right vertebral artery (VA) arise from the right subclavian artery (SA) and fuse at the level of the C5 or C4 transverse foramen, a variation of the artery termed duplicate origin. Usually, one channel arises from the normal position, and the second arises from the extreme proximal segment of the SA. We report a case of duplicate origin of the right VA in which both channels arose from the extreme proximal segment of the SA, which we diagnosed by computed tomography (CT) angiography. The smaller channel entered the C5 transverse foramen and the larger channel, the C4 transverse foramen, and they fused at the level of the C4. Careful scrutiny of CT angiographic source images is important to detect rare arterial variations, especially to identify the level at which the VA enters the transverse foramen.

Keywords Cerebral arterial variation · Computed tomography angiography · Duplicate origin · Right subclavian artery · Right vertebral artery

Introduction

There are several types of variation in the origin of the vertebral artery (VA): (1) direct aortic origin of the left VA proximal to the left subclavian artery (SA); (2) direct aortic origin of the left VA distal to the left SA; (3) duplicate origin of the left VA; (4) extreme proximal right SA origin of the right VA; (5) duplicate origin of the right VA; and (6) aberrant right VA [13]. Usually, when the right VA exhibits duplicate origin, one vessel arises from the normal segment of the right SA and enters the C6 transverse foramen, and another vessel arises from the extreme proximal segment of the right SA and enters the C5 or C4 transverse foramen [13].

We report a case in which both channels of the right VA arose from the extreme proximal segment of the right SA and entered the C5 and C4 transverse foramina, which we diagnosed by computed tomography (CT) angiography.

Case report

A 47-year-old woman with headache underwent magnetic resonance (MR) imaging and MR angiography using a 1.5-T scanner at a private hospital, which revealed a small unruptured aneurysm at the junction between the left internal carotid artery and ophthalmic artery.

She was transferred to our institution for further evaluation and treatment, and underwent CT angiography from the aortic arch to the intracranial region that confirmed the aneurysm. Two channels of the right VA arose from the extreme proximal right SA and fused at the level of the carotid bifurcation. The left VA arose directly from the aortic arch proximal to the left SA (Fig. 1). CT angiographic source images showed entry of the smaller channel of the right VA into the C5 transverse foramen. Both larger channels of the right and left VAs entered the C4 transverse foramina. The channels of the right VA fused at the level of the C4 (Fig. 2).

✉ Akira Uchino
auchino@saitama-med.ac.jp

[1] Department of Diagnostic Radiology, Saitama Medical University International Medical Center, 1397-1 Yamane, Hidaka, Saitama 350-1298, Japan

[2] Department of Neurosurgery, Saitama Medical University International Medical Center, Hidaka, Japan

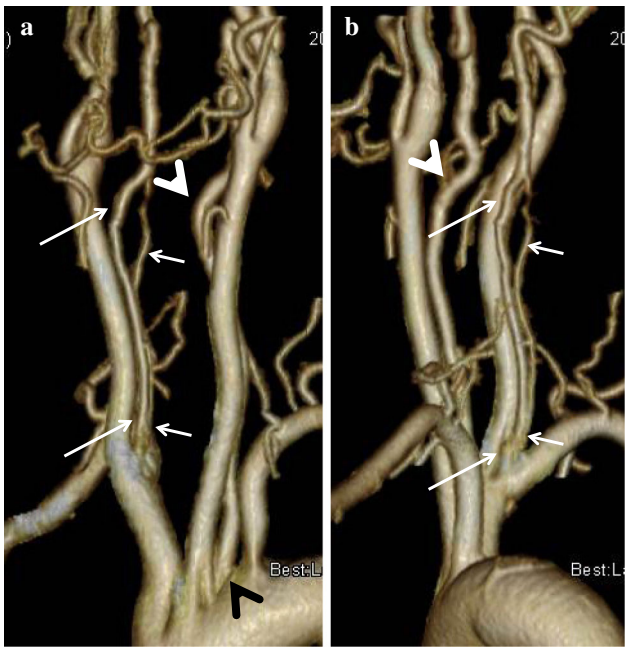

Fig. 1 Computed tomography angiography of the neck region. Left anterior oblique (**a**) and slightly left posterior oblique (**b**) projections of volume-rendering images show two arteries arising from the extreme proximal right subclavian artery (*long* and *short arrows*). The fusion of the arteries at the level of the carotid bifurcation indicates the duplicate origin of the right vertebral artery (VA). The left VA arises directly from the aortic arch and enters the transverse foramen at the level of the carotid bifurcation (*arrowheads*)

Catheter angiography was not performed, and the patient was treated conservatively because of the small size of the unruptured aneurysm.

Discussion

CT angiographic study has shown that the most prevalent variation in VA origin is the aortic arch origin of the left VA proximal to the left SA, and the second most prevalent is the extreme proximal right SA origin of the right VA [13]. Our patient had the most common variations bilaterally, but on the right side, the VA showed duplicate origin, an extremely rare variation [2, 3, 5–9, 11–13]. All patients previously reported had a right VA with a channel of normal origin and one of extreme proximal right SA origin that fused, but both channels of the right VA in this patient arose from the extreme proximal right SA. In general, variations related to the aortic arch, including variation in VA origin, can be explained using the double aortic arch model (Fig. 3) [4, 7, 10, 13], but the model can be inadequate when the variation is extremely rare. Though duplicate origin of the right VA usually develops from the persistence of both the right VA6 and right VA7 (Fig. 3), that of our patient formed by the persistence of only the right VA6 and the division of its proximal segment into

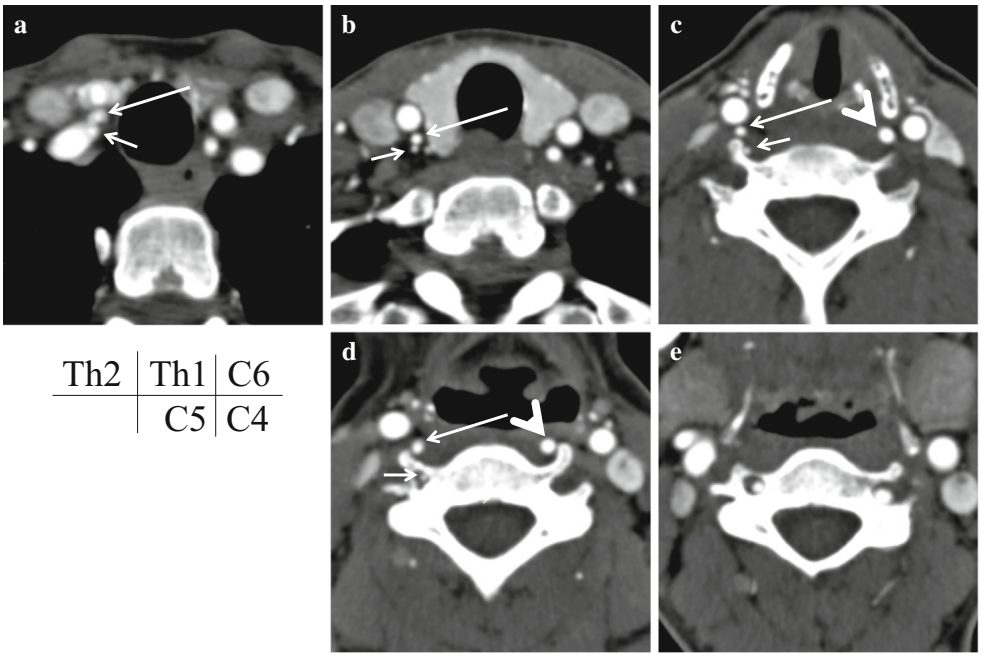

Fig. 2 Computed tomography angiography source images of the neck region. **a** At the level of the Th2 vertebral body, two channels of the right vertebral artery (VA) arise from the extreme proximal right subclavian artery (*long* and *short arrows*). **b** At the level of the Th1 vertebral body, two channels of the right VA ascend near to each other (*long* and *short arrows*). **c** At the level of the C6 vertebral body, bilateral VAs are not seen in the transverse foramina (all *arrows* and *arrowhead*). **d** At the level of the C5 vertebral body, the smaller channel of the right VA is seen in the transverse foramen (*short arrow*), but the larger channel of neither the right or left VA is seen in the transverse foramina (*long arrow* and *arrowhead*). **e**: At the level of the C4 vertebral body, the fused right and left VAs are normally seen in the transverse foramina

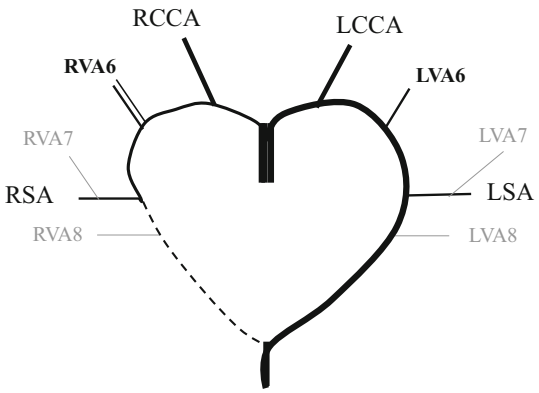

Fig. 3 Schematic illustration of the double aortic arch model (modified from Ref. [13]). Normally, the left vertebral artery (LVA) 6, LVA8, right vertebral artery (RVA) 6, and RVA8 regress, and the right aortic arch regresses at the segment distal to the right subclavian artery (RSA). The aortic arch origin of the left VA proximal to the left SA is formed by persistence of the LVA6. Duplicate origin of the right VA is usually formed by persistence of both the RVA6 and RVA7. However, in our patient, only the RVA6 persisted. The double aortic arch model does not readily provide the embryonic explanation for the duplicate origin (division of proximal segment) of the right VA in our patient

two vessels. Baik's group [2] recently reported a case of right VA duplicate origin in which both channels arose from the usual segment of the right SA. The double aortic arch model cannot account for these divisions. Neither can it account for an extremely rare variation in a patient reported by Akdeniz or associates [1], in which the right SA was aberrant and the right VA arose from the ascending aorta.

The VA is divided into four segments. The V1 (intrathoracic segment) extends from the origin of the artery to the entrance into the transverse foramen, usually at the C6. The V2 (intertransversal segment) runs in the transverse foramen from the C6 to C2. The V3 (atlantoaxial segment) extends from the C2 to the foramen magnum. The V4 (intracranial segment) takes an intradural course to connect the basilar artery.

It is well known that the VA enters the transverse foramen of the C5 or C4 in the case of a left VA of aortic arch origin proximal to the left SA and/or a right VA of extreme proximal right SA origin [13]. In our patient, the left VA arose from the aortic arch proximal to the left SA and entered the C4 transverse foramen, and the two channels of the right VA of duplicate origin arose from the extreme proximal right SA, entered the C5 (smaller channel) or C4 (larger channel) foramen, and fused at the level of the C4. Identification of the level of entry into the transverse foramen requires careful scrutiny of CT angiographic source images.

Because VAs that enter the C5 or C4 transverse foramen run anterior to the transverse foramen, they are dangerous during anterior neck surgery, including C6 stellate ganglion block. On catheter angiography, preprocedural identification of any anomalous branching VA reduces examination time and catheterization failure. Jung et al. [7] recently reported a case of left VA duplicate origin using selective catheter angiography mimicking an arterial dissection. Domenicucci and colleagues [3] reported a case of left VA duplicate origin associated with cervical congenital spondylolytic spondylolisthesis using CT angiography. In our patient, no anomaly was seen in the cervical spine.

Conclusions

We presented CT angiographic images of a patient with duplicate origin of the right VA in which both channels arose from the extreme proximal right SA. Careful examination of CT angiographic source images is important to discover and confirm rare variations.

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Compliance with ethical standards

Conflict of interest We declare that we have no conflict of interest.

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