



# Anomalous Origins of the Bilateral Vertebral Arteries Arising from the Aortic Arch: A Case Report

대동맥궁에서 기시하는 양측 추골동맥의 이상기시: 증례 보고

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Various anomalous origins of the vertebral arteries (VAs) have been reported. However, anomalous origins of the bilateral VAs arising directly from the aortic arch are extremely rare. We encountered a 60-year-old male who developed sudden-onset right hemiparesis with an incidentally discovered rare origins of the bilateral VAs from aortic arch. CT angiography demonstrated the right VA originating from the aortic arch distal to the left subclavian artery and left VA originating from the aortic arch between the left common carotid artery and the left subclavian artery. The possible embryological mechanism of this variant was also reviewed. If the VA can not be found in the usual position during the procedure, a rare variant of the VA with anomalous origin should be considered. Understanding these variations is important to avoid unexpected events during endovascular procedures or surgery.

**Index terms** Vertebral Artery; Aortic Arch; Anatomic Variation; CT Angiography

## INTRODUCTION

The vertebral artery (VA) typically arises as the first branch of the ipsilateral subclavian artery. Multiple variations in the origin of VA have been reported in the literature (1, 2). The left VA originating from the aortic arch between the left common carotid artery and the left subclavian artery is known to be the most frequent variation (2, 3). The anomalous origin of the right vertebral artery (RVA) originating from the aortic arch distal to the left subclavian artery is very rare (3). Here, we describe a rare case of these combined anomalous origins of the bilateral vertebral arteries with the help of CT angiography findings and discuss the possible embryological etiologies. Most anomalous origins of the VA are benign (3). However, understanding these variations is important

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to avoid unnecessary complications during endovascular interventions or surgical procedures.

## CASE REPORT

A 60-year-old male presented to the emergency department with sudden onset of right-sided hemiparesis. Diffusion weighted imaging (DWI) and CT angiography were performed. DWI showed a hyperintense lesion over the left MCA territory with a decreased apparent diffusion coefficient, consistent with an acute infarct (the figure was not shown). CT angiography revealed severe stenosis of the left internal carotid artery and the patient underwent carotid artery stenting immediately (Fig. 1A). Incidental anomalous origin of the bilateral vertebral arteries was also found (Fig. 1). Hypoplastic RVA originated from the aortic arch distal to the left subclavian artery as the last branch of the aortic arch, then coursed posterior to the esophagus and trachea, and entered the transverse foramen of the 7th cervical vertebra. A focal aneurysmal dilatation, reminiscent of a Kommerell diverticulum, was also present at the origin of the RVA. The dominant left vertebral artery (LVA) originated directly from the aortic arch, between the left common carotid and left subclavian arteries and entered the transverse foramen of the 5th cervical vertebra.

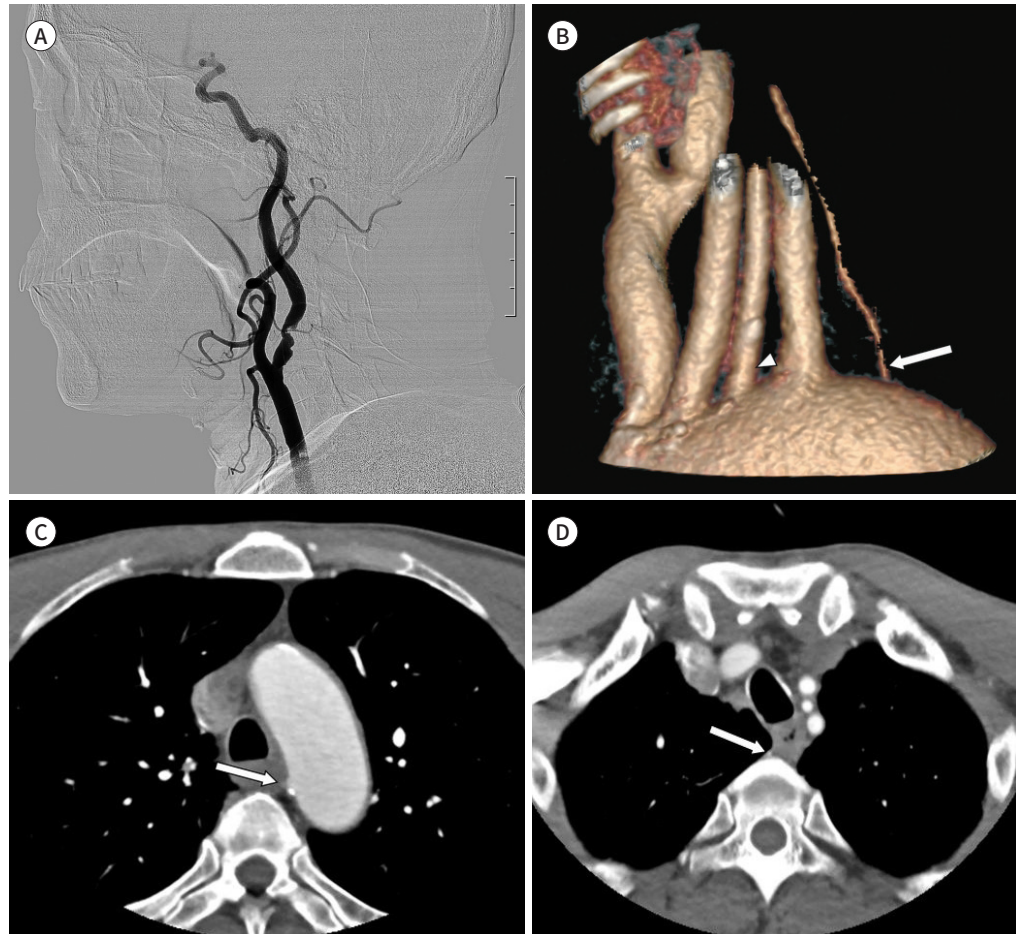
## DISCUSSION

Anatomical variations of the aortic arch and its major branches are commonly encountered on cross-sectional imaging (2). Typically, the right and left vertebral arteries originate as the first branches of the right and left ipsilateral subclavian arteries, respectively (2). Embryologically, the vertebral artery is formed by the development of the postcostal longitudinal anastomosis that links the cervical intersegmental arteries (1). However, variable anomalous origins of both the right and left vertebral arteries have been reported previously in the literature (1). The present case demonstrated the right brachiocephalic trunk originating from the aortic arch as the first branch, followed by the left common carotid artery, the LVA as the third, left subclavian artery as the fourth, while the RVA originated as the fifth and last branch on the left side of the aortic arch on CT angiography.

The most common variant is the LVA arising directly from the aortic arch between the left common carotid and left subclavian arteries (2, 3). Embryologically, the anastomosis between the 6th and 7th intersegmental arteries does not develop on the left side and the 6th intersegmental artery remains persistent, and then the left VA is originates from the aortic arch between the left common carotid and left subclavian arteries (4). In addition, Uchino et al. suggested that variations of the VA origin is closely related to its level of entry into the transverse foramen (5). Previous reports demonstrate that the LVA originating from the aortic arch most commonly entered the transverse foramen at C5 followed by C4 (5, 6). Consistent with previous studies, our case also illustrates that the LVA arising directly from the aortic arch enters the left transverse foramen at C5.

In contrast to the aortic arch origin of LVA, anomalous origins of the RVA are very rare (3) and may be divided into three categories: those originating from the carotid arteries or bra-

**Fig. 1.** A 60-year-old male with anomalous origins of the bilateral vertebral arteries arising from the aortic arch.  
**A.** Left carotid angiogram before carotid stent implantation in the lateral projection shows severe stenosis of the proximal left internal carotid artery.  
**B.** The left anterior oblique projection of three-dimensional volume-rendered CT angiography shows five vessels directly originating from the aortic arch: right brachiocephalic trunk, left common carotid artery, left vertebral artery (arrowhead), left subclavian artery, and aberrant RVA (arrow) from proximal to distal direction.  
**C.** The CT angiographic source image shows aberrant RVA (arrow) originating from the aneurysmal dilatation of the aortic arch.  
**D.** The axial CT image shows the course of the aberrant RVA (arrow) located posterior to the esophagus and trachea.  
 RVA = right vertebral artery

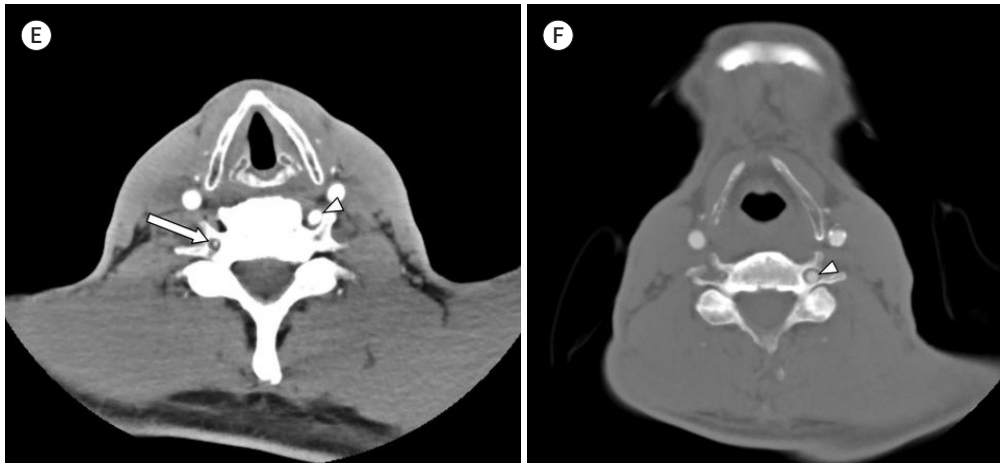


chiocephalic arteries, those of duplicate origins, and those originating directly from the aorta (1). Lemke et al. (1) reported the origin of RVA from the right common carotid artery, with a right subclavian artery originating distal to the left subclavian artery, being the most common type of anomalous origin of RVA. On the other hand, the RVA originating distal to the left subclavian artery is more rare entity (7). Previous studies have reported a bovine arch with aberrant RVA (2, 7). When the RVA arises embryologically from the C8 intersegmental artery and the physiologic obliteration of the right dorsal aorta is distal to the C7 intersegmental artery level, the origin of the RVA is shifted to the left, thus arising distal to the left subclavian artery (2). In this process, postcostal longitudinal anastomosis between the C1 and C8 intersegmental arteries can develop, and thus the aberrant RVA can enter the right

**Fig. 1.** A 60-year-old male with anomalous origins of the bilateral vertebral arteries arising from the aortic arch. **E.** The axial CT image of the 7th cervical vertebra level shows the RVA (arrow) located in the right transverse foramen. The LVA (arrowhead) is not seen in the left transverse foramen in this figure, but it is located anteriorly.

**F.** The axial CT image of the 5th cervical vertebra level shows the LVA (arrowhead) located in the left transverse foramen. The RVA is seen in the right transverse foramen.

LVA = left vertebral artery, RVA = right vertebral artery



transverse foramen of the C7 vertebra. The anomalous origin of the RVA arising from a position distal to the left subclavian artery showed aberrant entrance to the right transverse foramen at C7 (5-7). Consistent with previous reports, the present case also showed that the aberrant RVA enters the transverse foramen of the 7th cervical vertebra. This variation may be explained by the development of the postcostal longitudinal anastomosis between the C7 and C8 intersegmental arteries (Supplementary Fig. 1 in the online-only Data Supplement).

Several previous reports also demonstrate focal dilated origins of the aberrant RVA (2, 7). While the exact embryological explanation of the diverticulum of Kommerell is unclear, it is hypothesized that it is a remnant of the right dorsal aorta remaining as a focal aneurysmal dilatation, and which can explain its initial retroesophageal course (7). Our case also revealed aneurysmal dilatation at the origin of the anomalous RVA which coursed posterior to the esophagus and trachea.

The bilateral vertebral arteries originated from aortic arch is extremely rare (8-10). To the best of our knowledge, there are a limited number of cases that have reported the RVA arising distal to the left subclavian artery. Its association with anomalous origin of the LVA arising directly from the aortic arch between the left common carotid and left subclavian arteries has been reported twice before (9, 10). Schwarzacher and Krammer (9) described aberrant RVA entering the right transverse foramen of C7 and arch origin of the LVA entering the left transverse foramen of C5.

Recognition of the aortic arch anomaly including anomalous origin of VAs is important to avoid serious complication in surgeries for aortic arch or esophagus (5). Incomplete recognition of the variant can also lead to increase the procedure time and induce inadvertent complications such as dissection or distal embolization during the endovascular treatment. When the VAs enter the 3rd to 5th transverse foramen, they run anterior to the transverse process and can be at risk during anterior neck surgery (5). VA entering the 3rd transverse fo-

ramen may be a risk factor for obstruction or dissection during neck rotation (5). Although most anatomical variations of the aortic arch and its major branches are asymptomatic, it is important for radiologists to be familiar with them so as to avoid inadvertent vascular injury during endovascular procedures or surgical interventions (2, 3). Moreover, the possibility of an anomalous origin of the VA must be taken into consideration if a VA cannot be found in the usual position.

Here, we presented a rare case of anomalous origins of the bilateral vertebral arteries arising from the aortic arch. Both vertebral arteries show unusual entry into the transverse foramen as in CT angiography.

### Supplementary Materials

The online-only Data Supplement is available with this article at <http://dx.doi.org/10.3348/jksr.2020.0056>.

### Author Contributions

Conceptualization, L.B.H.; data curation, all authors; formal analysis, all authors; investigation, all authors; methodology, L.B.H.; project administration, L.B.H.; resources, all authors; supervision, L.B.H.; validation, L.B.H.; visualization, P.C.; writing—original draft, P.C.; and writing—review & editing, L.B.H.

### Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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## 대동맥궁에서 기시하는 양측 추골동맥의 이상기시: 증례 보고

박창현 · 이병훈\*

추골동맥의 기시부 변이의 다양성은 여러 문헌에서 보고되어 왔다. 그러나, 양측 추골동맥이 직접 대동맥궁으로부터 기시하는 변이는 매우 드물다. 이번 증례는 갑작스럽게 발생한 우측 편마비를 주소로 내원한 60세의 남자 환자에서 우연히 발견된 드문 양측 추골동맥 기시부의 변이를 보여준다. CT 혈관조영술에서 우측 추골동맥은 대동맥궁의 좌측 쇄골하정맥의 원위부에서 기시하였고, 좌측 추골동맥은 대동맥궁의 좌측 총경동맥과 쇄골하정맥의 사이에서 기시하였다. 이 변이와 연관이 있을 수 있는 발생학적인 기전도 고찰하였다. 추골동맥 기시부의 드문 변이의 가능성은 추골동맥이 일반적인 위치에서 보이지 않을 때 고려되어야 한다. 이 변이를 이해하는 것은 혈관 내 치료나 수술 중에 예기치 않은 합병증을 피하기 위해 중요하다.

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