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Case Report

Anomalous right vertebral artery arising from the arch of aorta: report of three cases

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ABSTRACT

The right vertebral artery most commonly originates as the first branch of the right subclavian artery. Although anatomical variants of the aortic arch are commonly encountered on cross-sectional imaging, certain variants of the right vertebral artery are exceedingly rare. In this report, we present 3 cases of aberrant right vertebral artery arising as the last branch of the aortic arch, a very rare variant.

Introduction

Vascular anatomical variants of the aortic arch are commonly encountered on cross-sectional imaging. Although variants of the aortic arch and its major branches are mostly asymptomatic, it is important for radiologists to be familiar with them for multiple reasons. Some are known to cause tracheoesophageal obstructive symptoms [1]. The presence of such a variant may also have implications related to angiographic or surgical interventions [2]. Here, we describe 3 rare cases of aortic arch variant in which the right vertebral artery arises distal to the left subclavian artery as the last branch of the aortic arch.

Case 1

A 45-year-old man with cutaneous Kaposi's sarcoma presented to our department to undergo a computed tomography (CT) scan of the chest. The goal of the CT scan of the chest was to screen for lung involvement by Kaposi's sarcoma. The CT scan of the chest revealed normal lungs; however, showed a rare anatomical variant of the aortic arch. Instead of arising as the first branch of the right subclavian artery, the right vertebral artery originated from the medial surface of the aortic arch, distal to the left subclavian artery (Fig. 1). The origin of the vessel was focally aneurysmal (Fig. 2). The right vertebral artery then coursed posterior to the esophagus before regaining its habitual route ascending in the neck through the transverse foramina of the cervical vertebrae (Figs. 3 and 4). In addition, the patient had a common origin of the brachiocephalic and left common carotid arteries, a very common arch variant known as a "bovine arch" (Fig. 5). The left vertebral artery originated normally from the left subclavian artery. The aberrant right vertebral artery was the dominant vertebral artery in this patient (Fig. 6).

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Fig. 1 – Case 1: Sagittal oblique maximum intensity projection (MIP) image of the computed tomography (CT) scan of the chest showing aberrant right vertebral artery arising as the last vessel of the arch (thin red arrow), distal to left subclavian artery (blue arrow). Also, note left common carotid artery (thick red arrow).

Case 2

A CT scan of the chest was performed in a 54-year-old man, who presented with axillary adenopathy, to rule out intrathoracic lymphoproliferative disease. The study demonstrated no intrathoracic pathological findings; however, an aberrant right vertebral artery originating from the aortic arch distal to the left subclavian was noted. The artery passed retroesophageally and eventually assumed the normal position within the right vertebral canal. A focal dilatation, reminiscent of a Kommerell diverticulum was noted at the origin of the aberrant artery (Figs. 7-9). The rest of the aortic arch vessels demonstrated normal configuration (Fig. 10). The left vertebral artery was dominant.

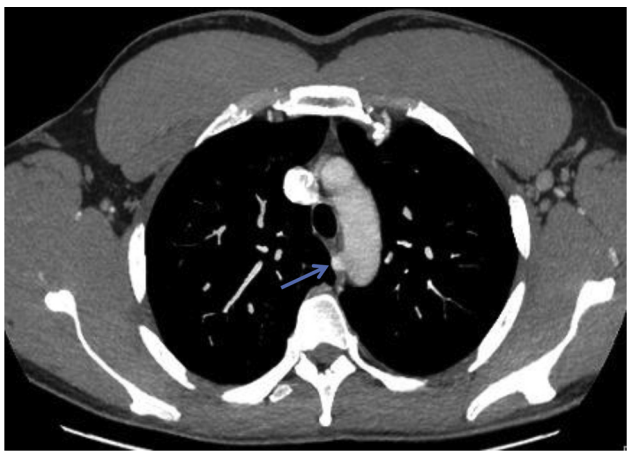

Fig. 2 – Case 1: Axial MIP image of the CT scan of the chest showing aneurysmal origin of the aberrant right vertebral artery (blue arrow) reminiscent of a Kommerell diverticulum.

Fig. 3 – Case 1: Axial image of the CT scan of the chest showing right vertebral artery (blue arrow) crossing the mediastinum posterior to the esophagus (red arrow).

Case 3

A 36-year-old man presented to the emergency department with signs of esophageal perforation. A thoracic CT scan

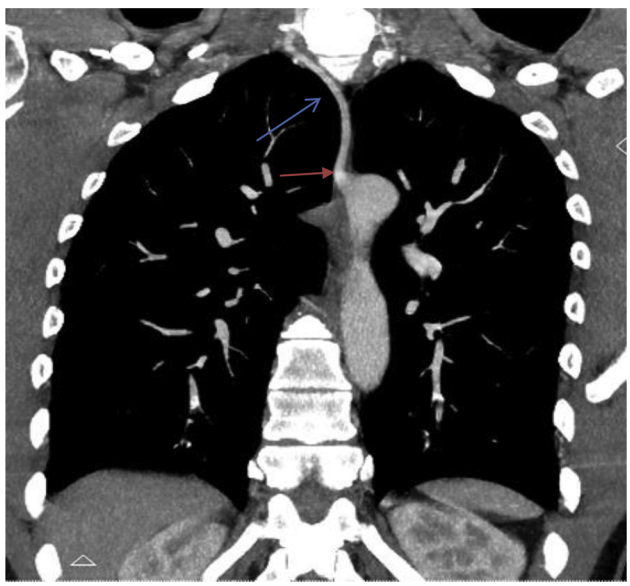

Fig. 4 – Case 1: Coronal oblique MIP image of CT scan of the chest showing proximal course of the aberrant right vertebral artery (blue arrow) from origin to cervical foramina. Notice the aneurysmal origin (red arrow).

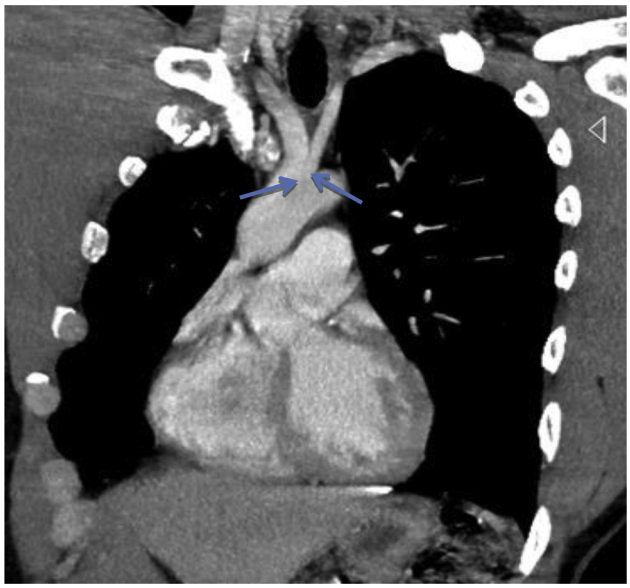

Fig. 5 – Case 1: Coronal oblique MIP image of CT scan of the chest showing "bovine" arch configuration (blue arrows).

revealed only incidental pulmonary infiltrates in the right lower lobe of probable infectious etiology. A rare variant of the right vertebral artery was noted, originating from the aortic arch distal to the left subclavian artery and coursing behind the esophagus, toward the normal right intravertebral canal. Again, a focal Kommerell diverticulum-like dilatation was present at the origin of this aberrant artery (Figs. 11 and 12); a concomitant bovine arch was present (Fig. 13). This patient demonstrated vertebral codominance.

Discussion

The aortic arch arises as a continuation of the ascending aorta at the level of the fourth thoracic vertebra. It is most commonly oriented from anterior to posterior and from right to left [3]. In

Fig. 6 – Case 1: Axial image of a CT scan of the chest showing the dominant aberrant right vertebral artery (blue arrow). The left vertebral artery is also seen (red arrow).

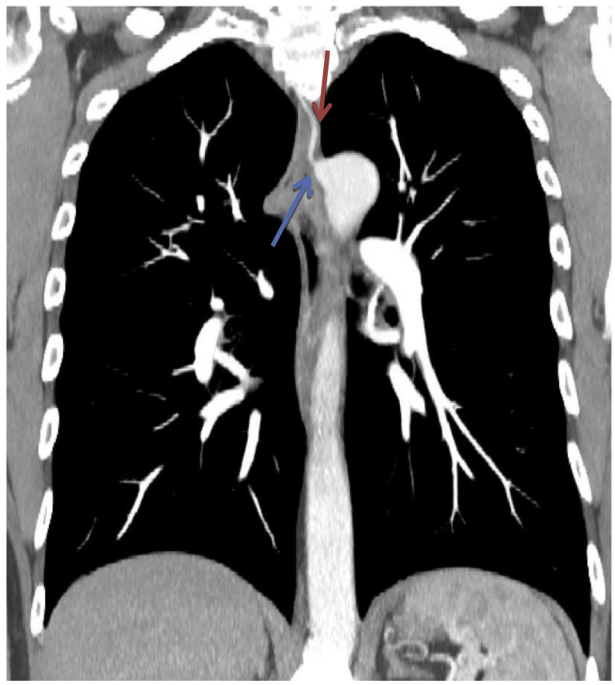

Fig. 7 – Case 2: Coronal oblique MIP image of CT scan of the chest showing right aberrant vertebral artery (red arrow), arising distally to the left subclavian artery. Note the Kommerell diverticulum-like focal dilatation at the origin of the artery (blue arrow).

around 70% of cases, it gives off 3 branches, which, arising from proximal to distal, are right brachiocephalic artery, left common carotid artery, and left subclavian artery [3]. The arch then terminates as the descending aorta at the level of the fourth

Fig. 8 – Case 2: Axial CT scan of the chest showing focal dilatation of the aberrant right vertebral artery at its origin (red arrow). The artery assumes a retroesophageal course.

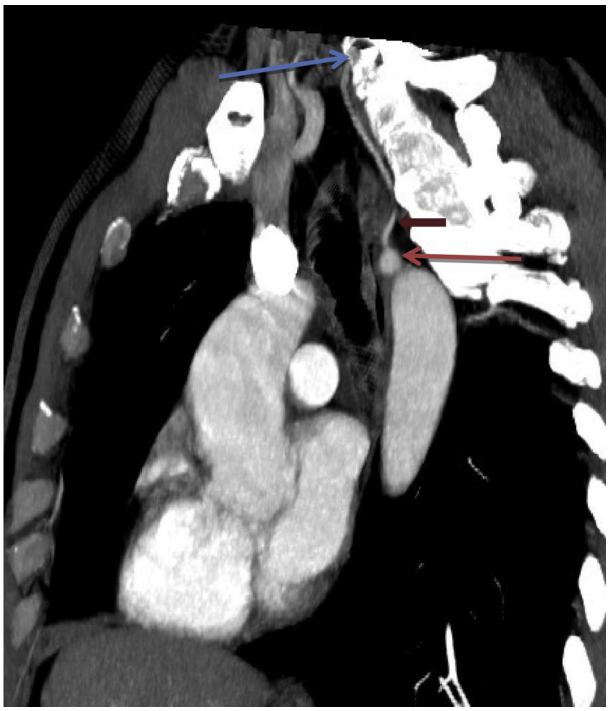

Fig. 9 – Case 2: Sagittal oblique MIP image of CT scan of the chest showing focal dilatation of the aberrant right vertebral artery origin (thin red arrow), retroesophageal course (thick red arrow), and entrance into the right vertebral canal (blue arrow).

thoracic vertebra. The commonest aortic arch variant is a "bovine arch" in which the brachiocephalic artery and the left common carotid artery have a common origin [4].

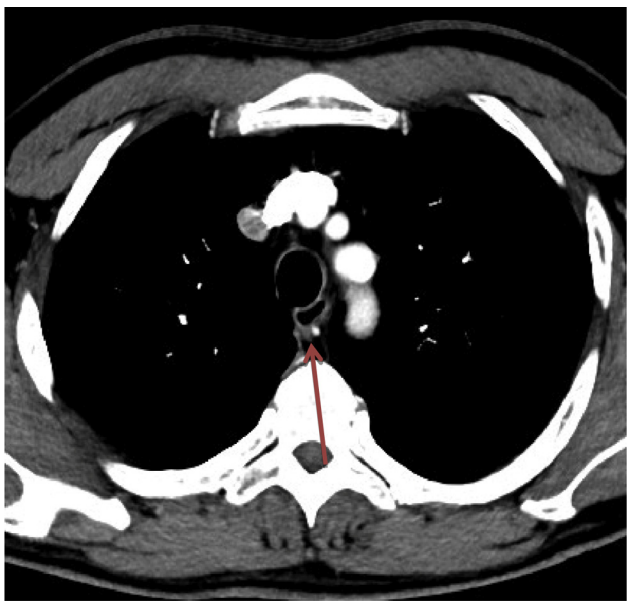

Fig. 10 – Case 2: Axial CT scan of the chest showing retroesophageal course of right vertebral artery (red arrow); note an otherwise normal configuration of aortic arch vessels.

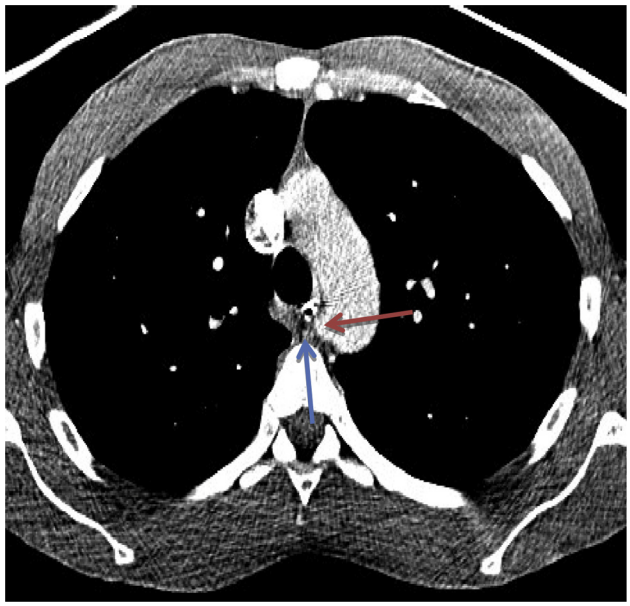

Fig. 11 – Case 3: Axial CT scan of the chest showing aberrant right vertebral artery, arising distally to the left subclavian and passing behind the esophagus (blue arrow). Kommerell-like diverticulum at the vessel origin (red arrow).

The right and left vertebral arteries most commonly originate as the first branches of the right and left subclavian arteries, respectively. Various types of anomalous origin of vertebral arteries have been reported. The commonest of

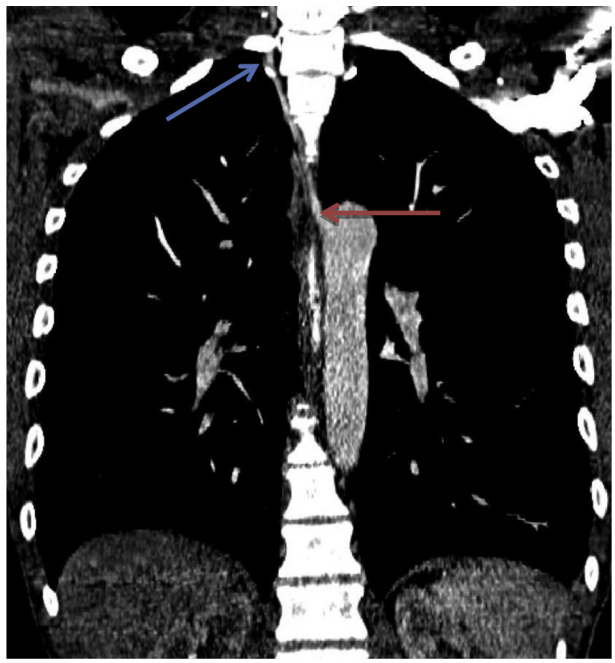

Fig. 12 – Case 3: Coronal oblique MIP image of CT scan of the chest showing aberrant right vertebral artery origin (red arrow), distal to the left subclavian artery and its subsequent normal course within the right vertebral foramen (blue arrow).

Fig. 13 – Case 3: Coronal oblique MIP image of CT scan of the chest showing common origin of the right brachiocephalic trunk and the left common carotid artery (red arrow).

these variants is a left vertebral artery arising directly from the aortic arch between the left common carotid artery and the left subclavian artery, seen in 3.1%-8.3% of cases [5]. Anomalies of the right vertebral artery are less frequently encountered, the commonest being its origin from the right common carotid artery, with a concomitant anomalous right subclavian artery origin as the last branch of the aortic arch [6]. In case of our patients, the right vertebral artery arose as the last branch of the aortic arch, distal to the left subclavian artery. In addition, a bovine arch was observed in 2 of 3 patients. To our knowledge, there are only 13 reported cases of right vertebral artery arising distal to the left subclavian artery, while its association with a bovine arch, similar to our patient, has been documented once before [7].

A detailed review of the embryological development of the aortic arch and brachiocephalic vessels is beyond the scope of this report. It is however important to acknowledge the many steps involved in the conversion of the pharyngeal arch system into the mature aortic arch and its branches. The aortic arch and its branches develop in a series of steps, which involve the fusion of paired dorsal and ventral aortas, the third and the fourth paired branchial arches, and the seventh intersegmental artery [8]. The first, second, and fifth paired branchial arches obliterate during development and the sixth contribute to the development of the pulmonary artery [8]. In normal anatomy, the right subclavian artery arises from the fusion between the primitive fourth branchial arch and the C7 intersegmental artery [6].The vertebral arteries develop from longitudinal anastomosis between C1 and C7 intersegmental arteries. There is then physiological obliteration of the right dorsal aortic arch distal to the C7 intersegmental artery [6,8] (Fig. 14). On the other hand, when the right vertebral artery exceptionally arises embryologically from the C8 intersegmental artery, rather than C7 (Fig. 15), the right dorsal aortic arch still obliterates distal to the C7 intersegmental artery level, and thus the origin of the right vertebral artery shifts to the left, arising distal to the left subclavian artery as the last branch of the aortic arch. The right subclavian artery continues to originate from the right aortic arch [6].

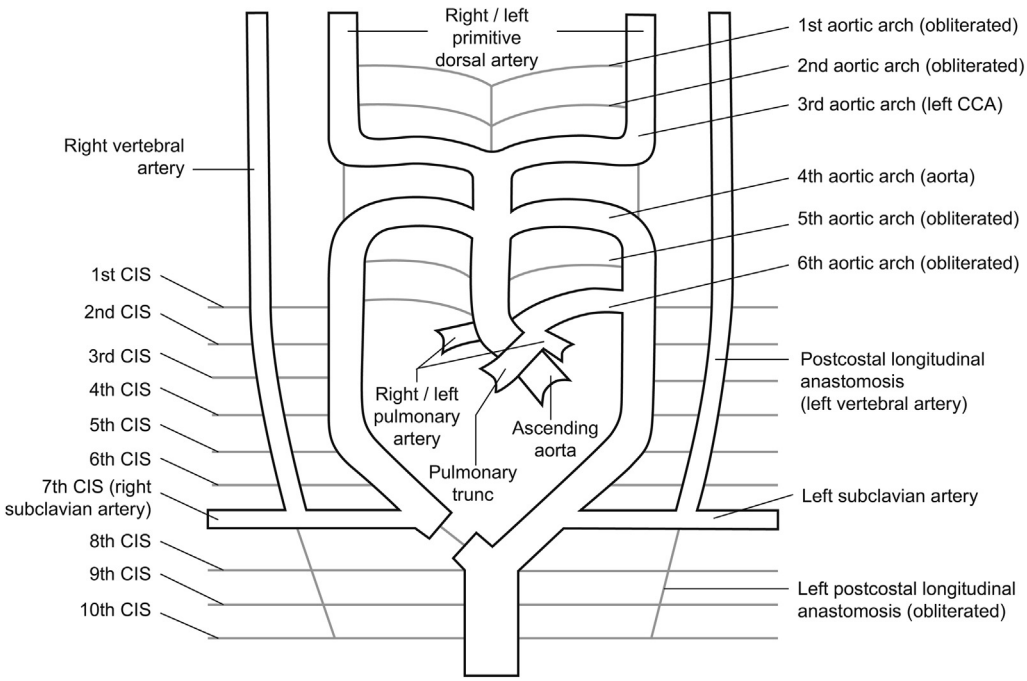

Fig. 14 – Drawing of the normal embryologic development of the aorta and brachiocephalic vessels (14-mm embryonic stage). CCA, common carotid artery; CIS, cervical intersegmental.

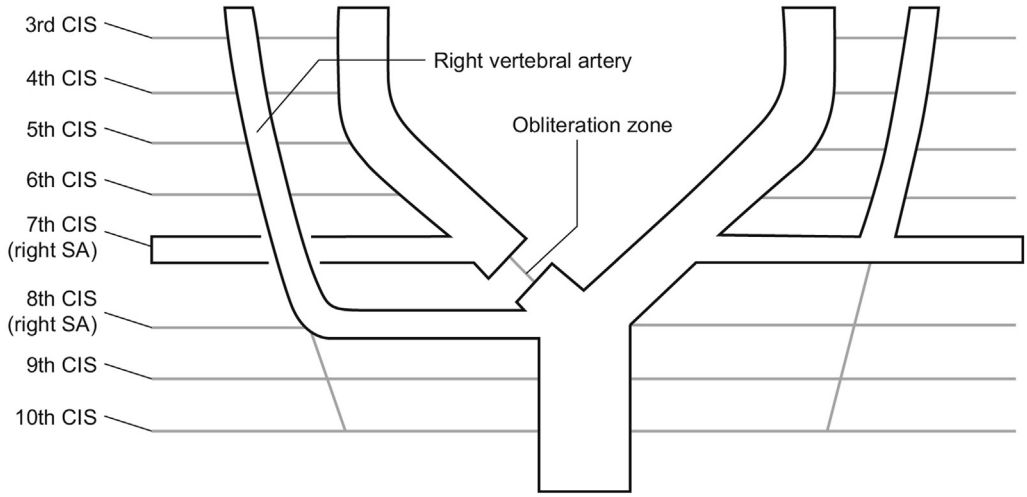

Fig. 15 – Drawing of the embryologic development of the aorta and brachiocephalic vessels (14-mm embryonic stage). Development of the right vertebral artery originating from the left and right subclavian artery arising from the right. CIS, cervical intersegmental; SA, subclavian artery.

Lie TA first reported this anatomical variant in 1968 [7]. To the best of our knowledge, there are 13 reported cases of anomalous right vertebral artery arising as the last branch of the aortic arch [7], and a single case reporting its association with a bovine arch [7]. Aberrant right vertebral artery has also been reported once in association with coarctation of the aorta [7]. Interestingly, all 3 patients described above demonstrate dilated origin of the aberrant right vertebral artery variant, reminiscent of a Kommerell-like diverticulum seen in the setting of aberrant right subclavian arteries. We found one report of a case describing a similar finding [9]. Also, we found that the aberrant right vertebral artery was the dominant vertebral artery in one patient, dominated in the second, and codominant in the third; however, no mention is made in prior reports of aberrant right vertebral artery dominance.

Although, most anatomical variants of the aortic arch are incidental findings, it is important to familiarize ourselves with them for several reasons. First, some are known to cause tracheoesophageal obstructive symptoms such as dysphagia, dysphagia lusoria, or stridor [7]. The presence of a variant may also have implications in cases of cerebral angiography and head and neck surgeries [2,4,6]. Knowledge of the arch variants can help avoid erroneous diagnoses of blocked arteries, when the vessel is not seen at its expected location during angiography or surgery, saves time during procedures, and avoids unnecessary instrumentation. Finally, a link between these variants and the presence of intracerebral malformations, such as aneurysms, has been hypothesized, possibly due to the resulting altered hemodynamics [7,8] and might warrant additional screening.

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