

Aberrant Right Subclavian Artery in Association with Common Trunk of Both Carotid Arteries: Diagnosis with CT

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ABSTRACT

The aberrant right subclavian artery (ARSA) is an anatomical abnormality encountered by anatomists and pathologists and more recently radiologists, interventional cardiologists and thoracic surgeons. The incidence of ARSA is 0.2-2% in the population. Cases of an ARSA in retro-tracheal and retro-oesophageal courses in association with common trunk of both carotid arteries have been rarely reported in literature. We reported the case of a retro tracheal RSCA, which originated distally along the left aortic arch and coursed behind the trachea and the oesophagus, diagnosed on computerized tomography angiography (CTA). This was associated with a rare variant of the aortic arch; in which the arch had a common trunk as first branch, which subsequently bifurcated to give the right and left common carotid arteries without any aneurysmal dilatation.

Key words: Aortic arch; brachiocephalic trunk; innominate; retro-tracheal; retro-oesophageal; subclavian artery

Introduction

With the increasing use of imaging studies, variant of the aortic arch has been identified more frequently.^[1] Though rare, the clinician should be aware of their existence to better the wide range of variants that occur in the arch and the great vessels. This will help in adequately managing these variations in emergency approaches to the arch and the great vessels when imaging studies are not available.^[2] In approximately, 80% of individuals, three branches arise from the aortic arch namely the brachiocephalic trunk, the left common carotid artery and the left subclavian artery.^[3] Adachi first described this branching pattern as type A.^[4] Another 11% of reported cases exhibit Adachi's pattern type B, which consists of a common trunk for the left common carotid artery and the subclavian artery. This branching pattern results in only two trunks originating from the aortic arch. The third pattern,

type C, is characterized by the left vertebral artery, originating proximal to the left subclavian artery as a fourth branch of the aortic arch. The remaining 1% of cases is composed of numerous other variations of aortic arch branching pattern. Thomson was able to identify nine different variations in the mode of origin of the branches arising from the aortic arch in 500 specimens.^[5] In five of these specimens (1%), he described a retro-oesophageal right subclavian artery (RRSA) and classified it as type D.^[6] Similar important contributions to the classification and description of the branching pattern of the aorta have been made by Quain^[7] and Henle.^[8] Thirteen cases of RRSA were reported from 1791 until 1868 but from 1868 till date, more than 100 cases of aberrant right subclavian artery (ARSA) have been described.^[5] Herein, we describe a rare of RRSA by computed tomography (CT) angiography, in which a left aortic arch gave rise to a right retro tracheal and retro oesophageal subclavian artery and a common carotid trunk, which subsequently bifurcated to yield right and left common carotid arteries.

Case Report

Forty years old man came in medical OPD with complaints of respiratory difficulty and mild dysphagia. They clinically suspected as mediastinal or esophageal mass. He underwent CT scan examination of chest in the Department of Radiodiagnosis

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in CT scan section; a unique branching pattern of the aortic arch was seen. While no obvious gross pathological changes or aneurysmal dilatation of the involved vessels was evident, it is unknown whether the anomaly was a contributory cause of respiratory difficulty and dysphagia. During the examination, an RRSA anomaly was recognized and the aorta (along with the proximal parts of its branches and its associated thoracic viscera) was reconstructed in three-dimensional (3D) planes and volume rendered tomography (VRT) images.

Thoracic and neck CT images showed an anomalous RSCA, which originated from the descending aortic arch [Figures 1 and 2]. Additionally, the short common trunk, which arose from the aortic arch as the first branch, subsequently bifurcated to yield the right common carotid artery and the left common carotid artery [Figure 3]. The aortic arch appeared otherwise unremarkable. The branches of the aortic arch (proximal to distal) were as follows: Common trunk of right common carotid artery and left common carotid artery, left subclavian artery and the last branch was

a retro-tracheal RRSA [Figure 4]. The RRSA coursed behind the esophagus and the trachea to reach the right-upper limb. Consequently, the brachiocephalic trunk was absent. The left vertebral artery arose normally from left subclavian artery [Figure 5]. There were no noticeable abnormalities in the heart or the remaining thoracic organs. The trachea and oesophagus were positioned normally. All abdominal viscera were also located normally. Both right and left recurrent laryngeal nerves looped normally around the right subclavian artery (RSCA) and aortic arch, respectively.

Discussion

Congenital variations of the aortic arch and great vessels are often encountered in radiological practice. They may be symptomatic or asymptomatic and discovered incidentally on imaging. It is important to recognize such variations on cross-sectional imaging modalities.^[9] Our patient complains was respiratory difficulty and mild dysphagia. The effect of the aberrant subclavian artery on the adjacent esophagus



Figure 1: Contrast enhanced axial computed tomography image shows aberrant right subclavian artery (open arrow)



Figure 2: Contrast enhanced sagittal computed tomography image shows aberrant right subclavian artery (open arrow)



Figure 3: Contrast enhanced coronal computed tomography image shows the common carotid trunk (open arrow)

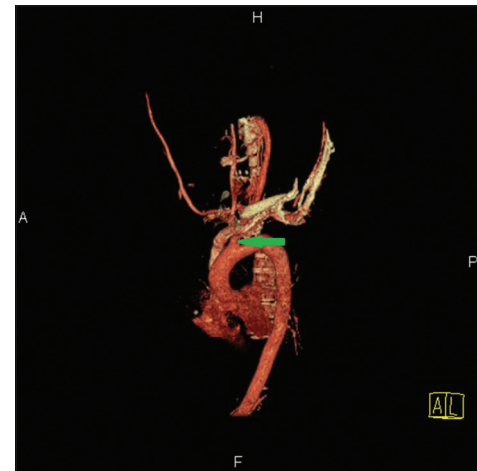


Figure 4: Anterior posterior projection volume rendered image shows origin of common carotid trunk (green arrow)

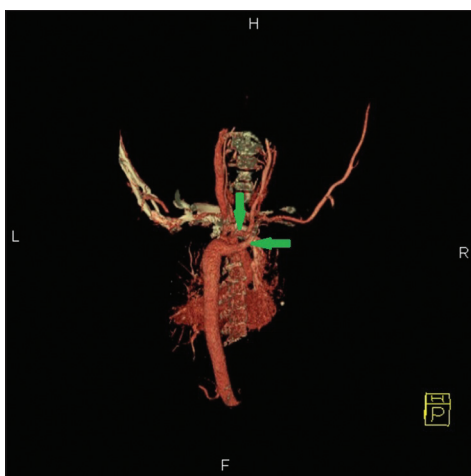


Figure 5: Posterior anterior projection volume rendered image shows origination of common carotid trunk (green vertical arrow) and aberrant right subclavian artery (green horizontal arrow)

was responsible for the dysphagia. It is unknown whether the anomaly was a contributory cause of respiratory difficulty or not. A variety of imaging modalities are available to demonstrate developmental abnormalities of the thoracic vascular system, and explain their embryological basis. Conventional angiography, the imaging gold standard is an invasive imaging modality but CT angiography can also be used as a non-invasive technique in demonstration of vascular anomalies since vascular anatomy can be shown with a high resolution. In addition, with the short scan times of modern CT scanners, study time is comparably shorter and this makes CT angiography more preferential, even in claustrophobic patients.^[10]

Embryologically, the third and fourth pairs of primitive aortic arches in the embryo build up the aortic arch system. The third pair gives rise to both carotid arteries, initially with a common trunk. The persistence of this stage explains a common carotid origin variant. An ARSA occurs when the right fourth arch and the proximal right dorsal aorta regress abnormally. The RSCA then develops from the right seventh inter-segmental artery and the distal right dorsal aorta.^[11]

Normally, three great vessels originate from the arch: The innominate artery, left common carotid artery, and left subclavian artery. The innominate artery subsequently branches into the right common carotid artery and the RSCA. Previous studies conducted in the Japanese population, the South African population, Negroes, Whites and Koreans showed marked differences in the incidence of the branching pattern of the aortic arch. This shows that racial differences may play a significant role in the branching pattern of the aortic arch.^[12] The incidence of this pattern is reported to be between 48% and 84%, with the wide variation largely attributable to differences between white and black individuals.^[13] It is generally accepted that this “normal” configuration occurs in approximately 70% of patients.^[13]

The next common variation occurs when the innominate artery and the left common carotid artery having a common origin. In this case, only 2 great vessels originate from the aortic arch. This aortic arch branching pattern is more often found in blacks, and previous cadaveric reports have documented occurrences in 25% of blacks but in only 8% of whites.^[6,12] Overall, this pattern of branching is seen in approximately 13% of cases.^[14]

Another variant is similar to the common origin variety, except that the left common carotid artery originates from the innominate artery more distally, rather than as a common trunk. In this instance, the left common carotid artery originates from the innominate artery at an average distance of less than 1 cm from the aortic arch with the maximum distance being 2.5 cm.^[13] This variant also occurs more commonly in blacks (10%) compared with whites (5%), with an overall rate of 9% in the general population.^[13,14]

The ARSA is the most common anomaly of the aortic arch seen in 1 of every 200 live births.^[15] ARSA has an incidence of 0.2-2% in the population.^[16] This anomaly is the result of obliteration and disappearance of the right fourth aortic arch and persistence of the dorsal aorta.^[17] Common carotid trunk (CCT) is another aortic arch anomaly described as ‘origin of carotid arteries’ from the innominate stem. This anomaly is extremely rare with a reported prevalence of <0.1%.^[17]

Ozates *et al.*, reported magnetic resonance (MR) angiographic findings in a patient suffering from dysphagia with RRSA and CCT.^[17]

Kurt *et al.*, also found an aortic arch anomaly with both ARSA and CCT in the cadaver of an old man during dissection.^[18]

Kersting-Sommerhoff *et al.*, correlated magnetic resonance imaging (MRI) diagnosis of 16 patients with aortic arch anomalies with angiographic, surgical and autopsy correlations in all, however, only one of the patients had a combined ARSA and CCT anomaly similar to the case presented.^[19]

Chahwan *et al.*, angiographically demonstrated an ARSA originating from the middle of the aortic arch with an anomalous origin of the left common carotid artery, sharing a common trunk with the innominate artery and a large right vertebral artery arising from the right common carotid artery. Although this particular combination of anomalies has been reported in cadaver cases, to their knowledge that was the first pre-mortem angiographic description in a patient, in which an ARSA originates from the middle of the arch between the anomalous bovine arch trunk and the left subclavian trunk. In this case presented, the right vertebral artery arose from the ARSA and the left vertebral artery arose normally from left subclavian artery.^[20]

Rogers *et al.*, also presented a case of an ARSA that had a retro-oesophageal course with coexisting common carotid trunk. The diagnosis was made on CT scan of the chest and angiography further delineated the pathology. The patient was managed by open ligation and transposition to the right carotid artery.^[21]

Aortic arch anomalies may present and can be confirmed in various ways. Fineschi *et al.*, diagnosed an ARSA during difficulty in selectively cannulating the left subclavian artery, for which aortography was performed. They demonstrated from left to right, an ARSA arising from distal aortic arch, coursing to the right behind the trachea and oesophagus, the left subclavian artery, and finally the common carotid trunk.^[22] Cummings *et al.*, also described an aberrant right subclavian artery (RSCA) originating as the last major branch of the aortic arch, which eventually led to failure of a transradial approach to coronary angiography. Subsequent arch aortography revealed an associated common carotid trunk. The combination of both anomalies as diagnosed on CT angiography in this reported case is a rare finding.^[23]

Mundayat *et al.*, diagnosed ARSA with common carotid trunk by CT angiography in a patient with dysphagia lusoria. Repaired this case of ARSA through the transcervical approach.^[24]

On conventional angiography Khatri *et al.*, reported a case of ARSA with common carotid trunk.^[25] Sangam *et al.*, reported a case of left sided aortic arch with three branches; a bi-carotid trunk, left subclavian artery and right subclavian artery. The anomalous RSCA traversed a retroesophageal course.^[26]

Baris *et al.*, reported a case of ARSA with co-existent common carotid trunk. On CT angiography, associated fusiform dilatation of the ascending aorta was noted while the descending aorta was normal. The left subclavian artery arose as the first branch of aortic arch while both common carotid arteries arose as a common trunk from the aortic arch as the second branch. In addition to these findings, the retro-tracheal and retro-oesophageal ARSA arose from the aortic arch as the last branch and coursed on the posterior aspect of trachea.^[10] Murzi *et al.*, reported a case of aneurysmal dilatation of the origin of a retro-oesophageal ARSA coexisting with a V-shaped CCT. The CCT arose as the first branch, followed by the left subclavian artery and the ARSA.^[27] In the case presented, the right and left common carotid arteries arose as a common trunk from aortic arch as the first branch. No aneurysmal dilatation or atherosclerotic plaque was however detected.

Conclusion

The coexistence of an ARSA with a common carotid trunk anomaly is a rare entity previously only detected on surgery or at autopsy incidentally. However, the condition can now

be diagnosed with conventional angiography, CT angiography and MR imaging. Conventional angiography is an invasive technique while MRI is expensive and not easily available. CT angiography is a non-invasive imaging option which can be used to diagnose aortic arch anomalies.

We diagnosed by CT angiography, a case of right and left common carotid arteries arising as a common trunk from aortic arch as the first branch, the left subclavian artery as the second branch and the RSCA was the last branch, coursing on the posterior aspect of oesophagus and trachea. The ARSA with coexistent common carotid trunk without any aneurysmal dilatation of the aorta or adjacent great vessels is a rare entity.

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