

## CASE REPORT

## Coexisting of aortic arch variation of the left common carotid artery arising from brachiocephalic trunk and absence of the main branches of right subclavian artery: a review of the literature

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### Abstract

The variations in the aortic arch and its branches are of surgical interest. Many anomalies of the aortic arch and great vessels are uncovered as serendipitous findings on imaging studies, in the anatomy laboratory, or at surgery. A 56-year-old woman had an arch angiogram as part of an evaluation for cardiovascular disease. A two-vessel left aortic arch was identified consisting of the brachiocephalic trunk and left subclavian artery. In this study, we present a case of the left common carotid (LCC) artery arising from the brachiocephalic trunk (BT) and absence of the main branches of right subclavian artery in her angiographic imaging findings. There is no previous report about LCC artery arising from BT and absence of the main branches of right subclavian artery in the same person.

**Keywords:** aortic arch variations, common origin, carotid arteries, angiography.

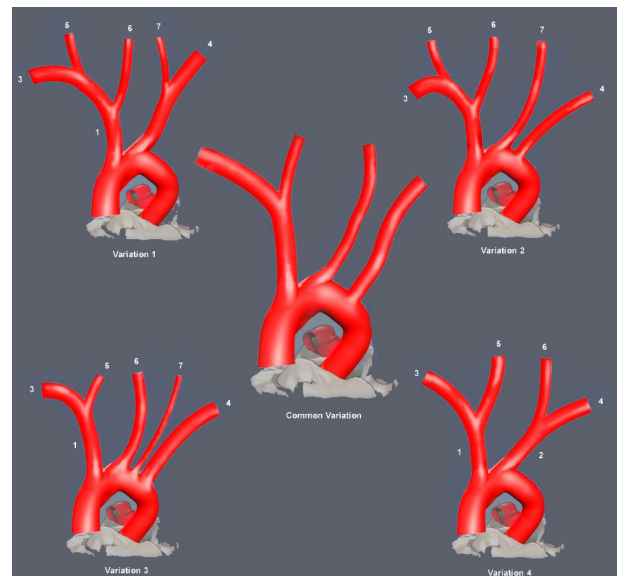
### Introduction

Many variations occur in the human vascular pattern, not only in the peripheral circulation, but also in large vessels including the aorta. Arterial variations of the aortic arch appear in a large number of possible combinations with various frequencies.

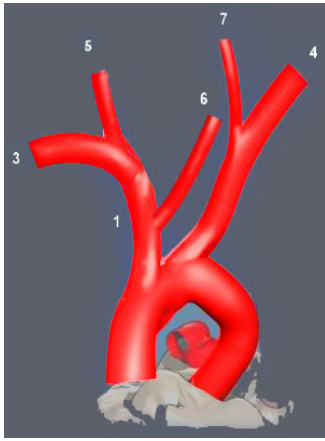
In about 80% of individuals, three branches arise from the aortic arch: the brachiocephalic trunk, left common carotid artery, and left subclavian artery [1]. Adachi first classified this branching pattern as type A. Another 11% of reported cases have a common trunk incorporating the left common carotid artery and the brachiocephalic leaving only two branches originating from the aortic arch, Adachi's type B. The third most common pattern, type C, has the left vertebral artery, a fourth branch of the aortic arch, originating proximal to the left subclavian artery [2]. Numerous other variations of the branching pattern of the aortic arch are found in less than 1% of cases [1]. In all reported cases, however, the most distal branch arising from the arch, or the descending thoracic aorta, was either a subclavian or thyroid ima artery [3, 4].

The position of the aortic arch may vary across the population. The possible variation of aortic arch can be seen in Figure 1. Common origin of the carotid arteries (COCA) is a normal aortic arch variant found in approximately 11% of whites [5] with an even higher incidence, up to 25%, reported in the African-American population [6]. In COCA, the right innominate and the left carotid arteries arise from a single origin or trunk of the aorta (Figure 2). Thus, the right and left common

carotid arteries both arise from a short "innominate" trunk [7]. Whereas previously it was reported that this defect had no associated anomalies or adverse consequences to the patient, more recent studies have indicated an increased incidence of COCA with certain congenital anomalies including DiGeorge syndrome, esophageal atresia-tracheoesophageal fistula [8] and anomalous origin of the left coronary artery from the pulmonary artery [9].



**Figure 1 – Schematic diagram of variations of aortic arch (1: right brachiocephalic trunk, 2: left brachiocephalic trunk, 3: right subclavian artery, 4: left subclavian artery, 5: right common carotid artery, 6: left common carotid artery, 7: left vertebral artery).**



**Figure 2 – Schematic diagram of LCA arising from brachiocephalic trunk (1: right brachiocephalic trunk, 3: right subclavian artery, 4: left subclavian artery, 5: right common carotid artery, 6: left common carotid artery, 7: left vertebral artery).**

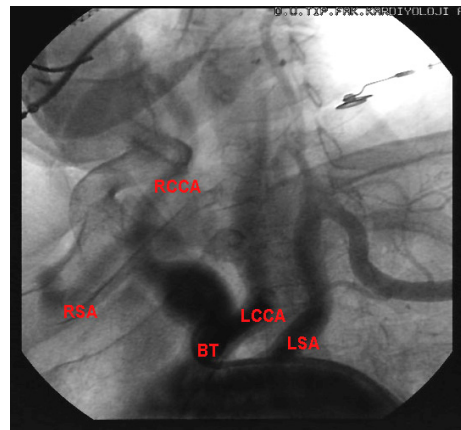
In addition, multiple congenital heart defects have been associated with COCA [5]. An increased incidence of stridor has been noted in infants with the COCA anomaly. Respiratory distress in the neonate with COCA has been attributed to superior mediastinal crowding [10].

The anomalous right subclavian artery is thought to develop because of the involution of the fourth aortic arch, which normally forms the innominate artery, and persistence of the seventh inter-segmental artery [11]. On the right side, the subclavian artery arises from the innominate artery behind the right sternoclavicular articulation; on the left side, it springs from the arch of the aorta. The two vessels, therefore, in the first part of their course, differ in length, direction, and relation with neighboring structures. In order to facilitate the description, each subclavian artery is divided into three parts. The first portion extends from the origin of the vessel to the medial border of the scalenus anterior; the second lies behind this muscle; and the third extends from the lateral margin of the muscle to the outer border of the first rib, where it becomes the axillary artery. The first portions of the two vessels require separate descriptions; the second and third parts of the two arteries are practically alike. Clinically, most important branch of the subclavian artery is the vertebral artery. Absence of the vertebral artery is rare, and incidentally encountered in radiological imaging techniques. Vertebral segmental agenesis is seldom reported [12]. A rete vertebralis is rare in animals [13]. Hyogo T *et al.* [14] and Karasawa J *et al.* [15] reported cases in Asian individuals. Although, Hachem K *et al.* [16] and Woodcock RJ *et al.* [17] reported a case of bilateral vertebral arteries agenesis. Kao CL *et al.* [18] reported a case of unilateral vertebral artery agenesis. Up to now, it has been not reported that LCC artery arising from BT and absence of RVA or other main branches of right subclavian artery in the same person. In terms of coexistence of these variations, this case report is so important knowledge of the embryonic aortic arch system is required to understand the development of anomalous branches arising from the arch of the aorta.

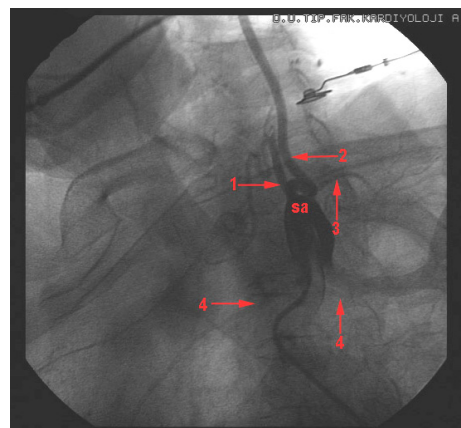
#### ☐ Patient, Methods and Results

A 56-year-old woman presented to Cardiac Catheterization Center at the Cardiology Department. The patient had history of the chest pain on exertion and dyspnea occurring over three to four months. The pain was

located on the left side of her chest with radiation to the left arm. Occasionally, the patient had sweating, stable angina and syncope. Physical exam, baseline electrocardiogram, electrocardiogram Holter and X-ray were normal. However, treadmill (electrocardiogram) test was positive. Coronary angiography was subsequently accomplished utilizing a 6F Judkins catheter to cannulate a single, ectopic ostium. There was no evidence of any coronary stenosis. Here, we present a case of the left common carotid artery arising from the brachiocephalic trunk (usually from the arch of the aorta) and absence of the main branches of right subclavian artery (Figure 3). Brachiocephalic trunk coursed towards on the right side, approximately 4 cm, and then gave off the left common carotid artery towards on the left side. At this level, there was explicit bulge in brachiocephalic trunk before dividing the right common carotid and subclavian arteries. After it coursed approximately 2 cm, it divided as the right common carotid and subclavian arteries. In addition, the remarkable finding was the right subclavian artery gave off no branches. On the other hand, the left subclavian artery gave off the vertebral, internal thoracic, thyrocervical, and costocervical arteries (Figure 4).



**Figure 3 – LCCA arising from brachiocephalic trunk and left subclavian artery gave off no branches in her angiographic imaging (BT: brachiocephalic artery, LCCA: left common carotid artery, RCCA: right common carotid artery, RSA: right subclavian artery, LSA: left subclavian artery).**



**Figure 4 – Main branches of left subclavian artery are shown (sa: left subclavian artery, 1: thyrocervical artery, 2: vertebral artery, 3: costocervical artery, 4: internal thoracic artery).**

## Discussion

There are several reports of blood vessel malformations associated with aortic arches [19–27]. Non-recognition of a critical aortic arch branch variation at surgery may lead fatal consequences [28]. Knowledge of the embryonic aortic arch system is required to understand the development of anomalous branches arising from the arch of the aorta. In this case report, we present a case of the left common carotid artery arising from the brachiocephalic trunk and absence of the main branches of right subclavian artery in her angiographic imaging findings. The remarkable point is these two anomalies being together. Although, left common carotid artery arising from brachiocephalic trunk [19–21, 23, 24] and absence of the vertebral artery [12, 15, 18] were reported individually in the literatures, it is the first case report in terms of LCC artery arising from BT and absence of the main branches of right subclavian artery together. Therefore, we discuss these anomalies developmental aspects.

The six pairs of aortic arches are a series of vessels that connect on each side the aortic sac with the corresponding dorsal aorta. At a later developmental stage, the aortic arches are both reduced in number and extensively transformed, and finally an asymmetric blood supply system is achieved. The first and second aortic arches largely disappear by the time the third to sixth arches develop, but the remaining parts of the 1st arch form the maxillary arteries. The common carotid arteries and proximal portions of the internal carotid arteries are embryonic derivatives of the third aortic arches [29, 30], which appear around the end of the fourth week of gestation; the distal portions of the internal carotid arteries are formed by the cranial portions of the dorsal aorta. The external carotid arteries are derived from portions of the ventral aortic roots [30]. The left limb of the aortic sac normally forms the part of the arch that intervenes between the origins of the brachiocephalic trunk and the LCC artery. If the aortic sac fails to bifurcate into right and left limbs, then the LCC artery will connect to the aortic sac directly. That results in a common origin of the carotid arteries (COCA). Gürbüz *J et al.* [31] reported that variations of the aortic sac and branchial artery system, from an embryologic standpoint, can be explained by the disappearance of normally persisting vessels or from the persistence of channels that normally disappear; however, reasons for subtle variations are not understood [32].

According to Anson *BI et al.*, the normal three-branched arrangement of the aortic arch is found in 64.9%. An arrangement distinguished by reduction in the number of stems to two, both common carotid arteries arising from the innominate occurs in 27.1% [33].

More rarely, the left common carotid and subclavian arteries arise from a left brachiocephalic or right common carotid and subclavian arteries arise separately, in which case the latter more often branches from the left end of the arch and passes behind the esophagus. This anomaly assumes some importance in the adult as well as in the child, as a cause of esophageal compression. The abnormal course of the “recurrent” laryngeal nerve, which accompanies this anomaly, is also impor-

tant [34]. Bhatnagar *KP et al.* reported that aortic arch passed to the right side of the esophagus and trachea and had four branches, from proximal to distal: left common carotid, right common carotid, right subclavian, left subclavian arteries. The ligamentum arteriosum connected the pulmonary trunk to the left subclavian artery and lay to the left of the esophagus and trachea. The left recurrent laryngeal nerve passed under the ligamentum arteriosum while the right recurrent laryngeal nerve passed under the aortic arch [35].

Adachi classified the branching pattern of the aortic arch into seven groups (groups A through G) based on his experience with the dissection of 516 Japanese cadavers. The arch vessel anomalies most frequently encountered were common brachiocephalic trunk (type B), isolated left vertebral artery (type C), and aberrant right subclavian artery (type G). According to his report, the frequency was 10.9% for common brachiocephalic trunk, 4.3% for isolated left vertebral artery, and 0.2% for aberrant right subclavian artery [2]. Williams *GD* and Edmonds *HW* reported their findings about arch vessel anomalies after dissecting 407 human cadavers: 191 American whites and 216 blacks. According to their report, the frequencies of arch vessel anomalies in white and black populations were 17.8% and 37.8% for common brachiocephalic trunk, 2.6% and 2.0% for isolated left vertebral artery, and 1.0% and 0% for aberrant right subclavian artery, respectively [6]. Our case report was classified as type B arch.

The incidence of congenital atresia or hypoplasia of the left vertebral artery is 3.1%, and of the right vertebral artery (RVA) it is 1.8% [36]. Woodcock *RJ et al.* reported a case report of bilateral proatlantal arteries, both vertebral arteries were absent [17]. Similarly, Hachem *K et al.* presented a case report of the absence of cervical segments of both vertebral arteries. MR-angiography performed on a 3T machine confirmed the bilateral absence of cervical segments and the presence of normal intracranial segments arising from the occipital arteries, branches of the external carotid arteries [16]. On the other hand, Kao *CL et al.* described the case of a 40-year-old woman who presented with a large aneurysm of the left vertebral artery in the angiographic absence of a right vertebral artery [18]. Above we mentioned case reports; there were no any congenital anomalies of aortic arches except for our case report.

## Conclusions

Even if congenital anomalies of aortic arch and absence of branches of subclavian artery are rare individually, it is so important that these two congenital anomalies being together. If a precise preoperative diagnosis cannot be established, unexpected results may be encountered in surgery or medical approaches. The possibility of their presence should be recognized for surgeons and anatomists.

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Received: February 3<sup>rd</sup>, 2010

Accepted: March 31<sup>st</sup>, 2010