Anomalous branching pattern of the aortic arch and its clinical applications

Shiva Kumar G L, Pamidi N, Somayaji S N, Nayak S, Vollala V R

ABSTRACT

The aortic arch gives rise to three classical branches, namely the brachiocephalic trunk, the left common carotid artery and the left subclavian artery. We report a rare variation of the left common carotid artery and the right vertebral arteries originating from the brachiocephalic trunk, and the left vertebral artery that was arising from the arch of the aorta, proximal to the origin of the left subclavian artery. Variations in the branching pattern of the arch of aorta can alter the cerebral haemodynamics that leads to cerebral abnormalities. Knowledge of the variations in the classical branches of the arch of aorta is important in the diagnosis of intracranial aneurysm after subarachnoid haemorrhage.

Keywords: aortic arch, brachiocephalic trunk, clinical applications, left common carotid artery, vertebral artery

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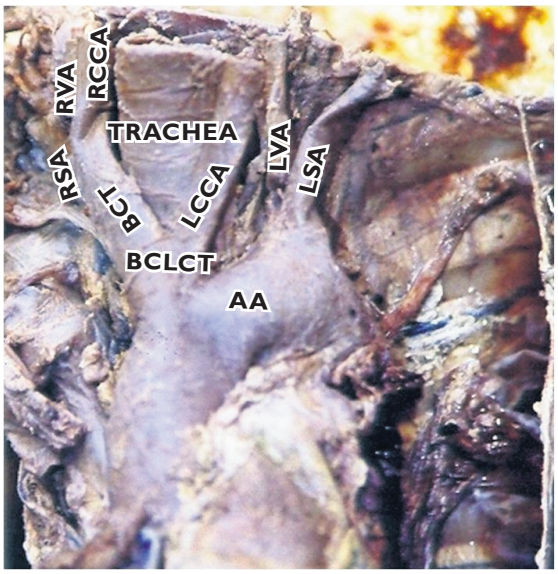

Fig. 1 Photograph shows the anomalous branching pattern of the aortic arch.
AA: aortic arch; BCLCT: brachiocephalic and left common carotid trunk; BCT: brachiocephalic trunk; RSA: right subclavian artery; RVA: right vertebral artery; RCCA: right common carotid artery; LCCA: left common carotid artery; LSA: left subclavian artery; LVA: left vertebral artery

INTRODUCTION

The aortic arch (AA) is located in the superior mediastinum. Its classical branches are the brachiocephalic trunk (BCT), the left common carotid artery (LCCA) and the left subclavian artery (LSA). These branches may originate from the commencement of the arch or from the upper border of the ascending aorta by varying distances between them. The BCT bifurcates into the right common carotid artery (RCCA) and the right subclavian artery (RSA). Occasionally, the LCCA can originate from the BCT (7%), and the LCCA and LSA rarely have a common origin in the form of the left brachiocephalic trunk from the aortic arch. The RCCA and RSA may originate individually from the aortic arch. The left vertebral artery (LVA) may arise between the LCCA and LSA. The right vertebral artery (RVA) and LVA may arise as separate branches from the aortic arch. In a case study that involved 1,000 aortic arches, the classical branching pattern of the aortic arch was observed in 65% of cases, the four great arteries arising separately from the aortic arch, in 2.5% of cases and the incidence of right and left BCT, in 5% of cases.[1]

CASE REPORT

The present case was observed while dissecting the cadaver of a 55-year-old South Indian man during dissection classes for medical undergraduates in the anatomy department. In this case, the aortic arch was giving rise to an unusual common trunk for the BCT and LCCA (Fig.1). The BCT was trifurcated into the RCCA, RVA and RSA. The LCCA was found to originate from the root of the BCT (innominate artery), cross the trachea anteriorly from left to right and then enter the left side of the neck (Fig. 2). The LVA was seen to arise from the arch of the aorta proximal to the origin of the LSA. The further course and branching pattern of the abovementioned arteries were normal. The brachiocephalic veins showed no variation in formation, course or termination.

DISCUSSION

Paraskevas et al reported the origin of LCCA from the initial portion of the BCT in the cadaver of an 81-year-

Kamineni Institute of Medical Sciences, Narkatpally, Nalgonda, Andhra Pradesh 508254, India

Shiva Kumar GL, MBBS, MS
Associate Professor

Melaka Manipal Medical College, Manipal University, Karnataka 576104, India

Pamidi N, MSc
Lecturer

Somayaji SN, MSc, PhD
Professor

Nayak S, MSc, PhD
Professor

Vollala VR, MSc, PhD
Assistant Professor

Correspondence to:
Dr Narendra Pamidi
Tel: (91) 820 2922 642
Fax: (91) 820 2571 905
Email: narendra.pamidi@gmail.com

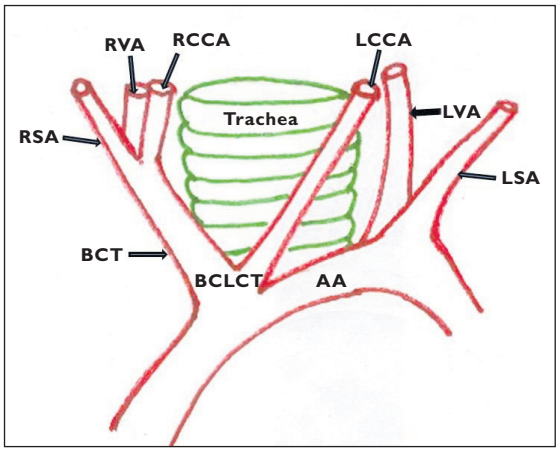

Fig. 2 Schematic diagram shows the anomalous branching pattern of the aortic arch.
AA: aortic arch; BCLCT: brachiocephalic and left common carotid trunk; BCT: brachiocephalic trunk; RSA: right subclavian artery; RVA: right vertebral artery; RCCA: right common carotid artery; LCCA: left common carotid artery; LSA: left subclavian artery; LVA: left vertebral artery.

old Caucasian man; the frequency of this occurrence was reported as 0.2%. This could be attributed to alterations in the development of the embryonic aortic arch system into the adult arterial pattern. Most anomalies arise due to the persistence of parts of the aortic arches that normally disappear, or due to the disappearance of parts that normally persist.[2] Vertebral arteries may arise as independent branches from the aortic arch, and the LVA may arise between the LCCA and LSA; the RCCA and RSA can seldom arise separately, in which case the RSA more often branches from the left end of the arch and passes behind the oesophagus.[1,3] This anomaly may lead to oesophageal compression and laryngeal complications due to the abnormal course of the "recurrent" laryngeal nerve accompanying the RSA.[4-6] The frequency of LVA originating from the aortic arch is 8%; this may be due to the increased absorption of embryonic tissue of the LSA between the origin of the aortic arch and the vertebral artery. Variations in cases of more than three branches originating from the aortic arch may include the vertebral arteries.[7,8]

A study by Nayak et al reported the classical branching pattern of the aortic arch in 91.4% of 62 cadavers, and the LVA arising from the AA, in 1.6% of the cases. This anomalous branching pattern of the AA can be attributed to developmental changes in the fusion process and the absorption of some of the aortic arches into the aortic sac.[9] Bergman et al reported a case of the RVA directly arising from the aortic arch, and the frequency of the BCT providing origin to the LCCA was 11%, with the LSA arising independently from the arch. The variations in the BCT are of surgical interest. It may give rise to the thyroidea ima artery, and more rarely, the vertebral and inferior thyroid arteries. The BCT is sometimes absent (0.44%).[10]

The anomalous branching pattern of the aortic arch can alter the cerebral haemodynamics, which in turn can lead to cerebral abnormalities. In aortic arch surgeries, these anomalous branches should be detected prior to the surgery. The ligation of the common carotid artery may lead to complications in the posterior cranial fossa blood supply if the vertebral artery originates from the carotid artery or through its branches.[11] Knowledge of the variations in the classical branches of the aortic arch is important in the diagnosis of intracranial aneurysm after subarachnoid haemorrhage.[2] Aortic arch anomalies can occur due to defects in the modes of transformation of the primary vessels of the fourth arch, and are associated with anomalies of the heart. Irregular and imperfect development of the septum between the aorta and the pulmonary trunk may produce variations, as they develop from the conus arteriosus.[10] Clinicians and surgeons should be aware of aortic arch variations. Prior identification of these vascular anomalies through diagnostic interventions is crucial in order to avoid complications during heart and vascular surgeries.

REFERENCES

1. Standring S. Gray's Anatomy. 39th ed. Edinburgh: Elsevier Churchill Livingstone, 2005: 1021-3.
2. Paraskevas G, Agios P, Stavrakas M, Stoltidou A, Tzaveas A. Left common carotid artery arising from the brachiocephalic trunk: a case report. Cases J 2008; 1:83.
3. Healey J, Hodge J. Surgical Anatomy. 2nd ed. Toronto: BC Decker, 1990: 110-1.
4. McVay CB. Anson and McVay Surgical Anatomy. 6th ed. Philadelphia: Saunders, 1984: 426-33.
5. Stone WM, Brewster DC, Moncure AC, et al. Aberrant right subclavian artery: varied presentations and management options. J Vasc Surg 1990; 11:812-7.
6. Azakie A, McElhinney DB, Dowd CF, Stoney RJ. Percutaneous stenting for symptomatic stenosis of aberrant right subclavian artery. J Vasc Surg 1998; 27:756-8.
7. Lemke AJ, Benndorf G, Liebig T, Felix R. Anomalous origin of the right vertebral artery: review of the literature and case report of the right vertebral artery origin distal to the left subclavian artery. AJNR Am J Neuroradiol 1999; 20:1318-21.
8. Nelson ML, Sparks CD. Unusual aortic arch variation: distal origin of common carotid arteries. Clin Anat 2001; 14:62-5.
9. Nayak SR, Pai MM, Prabhu LV, D'Costa S, Shetty P. Anatomical organization of aortic arch variations in India: embryological basis and review. J Vasc Bras 2006; 5:95-100.
10. Bergman RA, Afifi AK, Miyauchi R. Aorta: arch and thoracic part of the descending aorta. Available at: anatomyatlases.org/AnatomicVariants/Cardiovascular/Text/Arteries/Aorta.shtml. Accessed November 15, 2009.
11. Flynn RE. External carotid origin of the dominant vertebral artery. Case report. J Neurosurg 1968; 29:300-1.