

A STUDY ON BRANCHING PATTERN OF ARCH OF AORTA WITH ITS EMBRYOLOGICAL SIGNIFICANCE AND REVIEW OF LITERATURE

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ABSTRACT

Introduction: The Arch of Aorta normally provides three major branches from its convex surface, before descending down as the thoracic aorta. The branches arranged from right to left are the brachiocephalic trunk, the left common carotid artery and the left subclavian artery. The right common carotid artery and the right subclavian artery are given off by the brachiocephalic trunk. Any variation in the origin and arrangement of these branches are considered to be deviations from the normal process of development of the aortic arches.

Objective: To observe the variation in the branches arising from the aorta and to correlate with embryological development and discuss clinical significance.

Materials and Methods: The study involved 36 formalin fixed cadavers, 12 female and 24 male cadavers, which were used for routine dissection and teaching purposes for the first year medical students in the department of Anatomy, P.E.S Institute of Medical Sciences and Research.

Results: The arch of aorta was normal in 33 of the 36 cadavers. There were three cadavers which showed variation in the origin of branches from the arch of aorta. The variations were different in each of the cadavers and the same were discussed in detail while comparing with available literature.

Conclusion: The variation in the arch of aorta is due to involution of some parts of the arterial arches during development. In this study the origin of right subclavian artery from the distal part of arch of aorta and passing posterior to esophagus is a significant variation to be noted. We also observed that In the present study it was not present close to the left subclavian artery but deviated to the right behind the esophagus from the distal part of the arch and did not form a ring. This can have clinically significant symptoms and signs related to pathology in the esophagus or during deglutition.

KEY WORDS: Common Carotid Trunk, Aberrant Right Subclavian Artery, Variant Arch Of Aorta.

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INTRODUCTION

The Arch of Aorta normally provides three major branches from its convex surface, before descending down as the thoracic aorta. The branches arranged from right to left are the brachiocephalic trunk, the left common carotid artery and the left subclavian artery. The right common carotid artery and the right subclavian artery are given off by the brachiocephalic trunk. Standard textbook analysis of variation reports the usual pattern of three branches in 65%. There may be four separate branches in 2-5% only and a great variety of patterns are seen in 5%. Sometimes left common carotid artery shared the brachiocephalic trunk in 27% of individuals. 1-2% showed symmetric right and left brachiocephalic trunks [1].

During the normal development of the pharyngeal arch arteries, the right fourth pharyngeal artery becomes the proximal part of the right subclavian artery. The right dorsal aorta and the right seventh intersegmental artery form the distal part of the right subclavian artery. When there is abnormal involution of this segment of the artery cranial to the seventh intersegmental artery then it results in the anomalous formation of the right subclavian artery from the right seventh intersegmental artery and distal part of right dorsal aorta [2].

Unrecognized variations in the vascular anatomy may cause complications in open surgery on the aortic arch (3) Any variation in the origin and arrangement of these branches are considered to be deviations from the normal process of development of the aortic arches.

MATERIALS AND METHODS

The study involved 36 formalin fixed cadavers, 12 female and 24 male cadavers, which were used for routine dissection and teaching purposes for the first year medical students in the department of Anatomy, P.E.S Institute of Medical Sciences and Research. Observation in variations of the arch of aorta were made when the superior mediastinum was opened up by conventional dissection method as per Cunningham manual of Practical Anatomy to demonstrate the structures. The arch of aorta was examined and the branches arising from it

were noted in all the cadavers. The variations were photographed and noted down.

OBSERVATIONS

Fig. 1A: Shows common trunk for carotid arteries (CCT), arising from arch of aorta (AA).

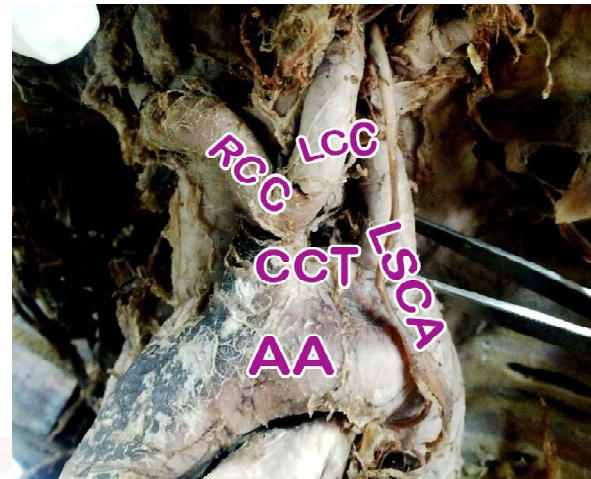


Fig. 1B: Shows Right common carotid artery (Rt. CCA) arising from descending aorta and passing posterior to esophagus.

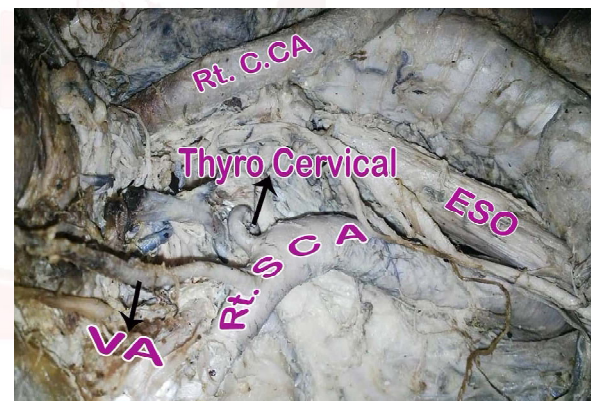
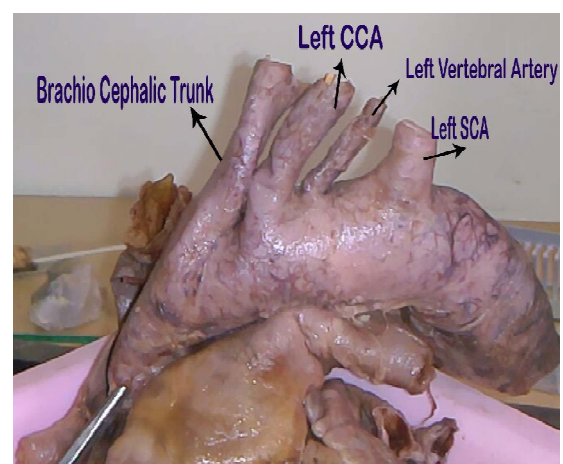


Fig. 2: Showing left vertebral artery arising from arch aorta.



The arch of aorta showed three different variations in three different cadavers. Fig 1A shows the common carotid trunk for right and left carotid arteries. Fig 1 B shows the right

subclavian artery arising from the terminal portion of the arch almost at the commencement of the descending aorta. Therefore the photograph was taken totally from the right side as the artery had deviated to take a right side course behind the esophagus at its origin itself. Fig 2 shows the origin of four separate branches from the arch.

The Arch of Aorta normally provides three major branches from its convex surface, before descending down as the thoracic aorta. The branches arranged from right to left are the brachiocephalic trunk, the left common carotid artery and the left subclavian artery. The brachiocephalic trunk gives off the right common carotid and right subclavian arteries.

The arch of aorta was normal in 33 of the 36 cadavers. There were three cadavers which showed variation in the origin of branches from the arch of aorta. The variations were different in each of the cadavers. The first variation noted was that the arch had two branches arising from it. The first branch was a common trunk for the brachiocephalic trunk and left common carotid artery and the second branch was the left subclavian artery. The second variation noted was that there were three branches from the arch. The first branch was a common trunk which gave rise to the left and right common carotid arteries (Fig 1A) the second branch was the left subclavian artery and the third branch the right subclavian artery, was placed at the termination of the arch of aorta almost arising from the descending part of the aorta and passing posterior to esophagus.(Fig 1B) The third variation noted was that there were four branches from the arch and were placed in sequence from right to left as the brachiocephalic trunk, the left vertebral artery, the left carotid artery and the left subclavian artery (Fig 2).

DISCUSSION

H.A. Alsaif et al [3] found that out of 36 specimens 27(75%) had the most common pattern of three major branches, the BT, LC and LS, from the arch of aorta. They reported that 66.66% of the variants had two branches in which one was the common trunk for brachiocephalic trunk and left common carotid, the other branch the left

Budhiraja V et al [4] found variations in 19 cadavers (36.5%). Ten cadavers(19.2%) had only two branches that arose from the arch. They were LSA and a common trunk for BCT and LCCA. Eight cadavers (15.3%) had four branches arising from the arch. From right to left they were the BCT, LCCA,LVA, LSA. In one cadaver (1.9%) 3 branches arose and they were the CT,LVA and LSA. The two branch pattern results from failure of the aortic sac to bifurcate, thus resulting in the LCCA connecting to aortic sac directly. The pattern is then a bicarotid trunk or a common trunk for BCT and LCCA. They attempted to explain that the left sixth segmental artery might have persisted as the first part of LVA or that it was due to increased absorption of embryonic tissue of LSA between origins from the aortic arch to the origin of vertebral artery. This resulted in direct origin of left vertebral artery from aortic arch.

PasaogluLale et al [5] in a study of 881 patients who underwent neck CT angiography, reported that 87.4%(770) of patients had classic branching pattern of the aortic arch (AA). Variations were seen in 111(12.6%) patients. The most common variation was seen in 64 cases (7.2%) in which the origin of LCCA was from the brachio-cephalic trunk (BCT). In the literature 10-20% has been reported called the "bovine aortic arch".This variation relates to symptoms of mediastinal widening as reported by K.P.Karkoulis [6]. The two branched pattern of the AA has been explained on the basis of failure of Aortic sac to bifurcate into left and right limbs. Normally the aortic sac bifurcates into right and left limbs. The right limb becomes the brachiocephalic artery. The left limb forms part of the arch that intervenes between origins of BCT & LCCA. In the present study there was one case with a common trunk for BCT & LCCA. The left vertebral artery(LVA) originated directly from the AA between the origin of LCCA and left subclavian artery (SCA) in 25 (2.8%) cases therefore providing a four branched pattern.

There are a few studies that have identified the right subclavian artery arising from the aortic arch. According to J.V.Richardson et al [7] the right subclavian artery is the last branch of the AA in approximately 1% of individuals. In the literature the percentage range is between 0.13% and 25% R.A Bergman, A.K.Afifi [8].

S.Kadir et al [9] has cited Right subclavian artery courses to the right behind the esophagus in 80% of cases, between the esophagus and trachea in 15% and anterior to the trachea or mainstream bronchus in 5%. The variation that passes anterior to trachea or mainstream bronchus is called "arterialusoria" and is one of the most common vascular ring variations of the AA.

The most frequent variation that accompanies the right aberrant subclavian artery has been a common trunk for carotid arteries 20.6-29% as reported by K.L.Natsis, et al (10) in their study in 633 angiographies. They have described eight types of aortic arches, (I-VIII) after investigating aortic arches of 633 patients who underwent digital subtraction angiography.

In the present study a type-III variation was found which describes the left vertebral artery as arising from the arch of aorta (Fig.2). In Type-IV common carotid arteries originate from common trunk. In this type the order of vessels from right to left is right subclavian artery, right and left common carotid arteries leaving from a common trunk and left subclavian artery. In Type-V: common carotid arteries originate from a common trunk and a right aberrant subclavian artery is present. In the present study a common trunk was seen for carotid arteries. The right subclavian artery originated far below the arch at the commencement of the descending aorta and coursed upwards behind the esophagus (Fig. 1A & 1B).

In the study by Pasaoglu [5] only the types I, II, III of Natsis et al (10) were present. They have stated that in their study that the incidence of double aortic arch (0.1%), right aortic arch (0.3%) and right vertebral artery which originated from the aortic sac as a last branch (0.1%) was observed. They have also stated that these variations were not included in the classification by Natsis et al. Pasaoglu et al has stated that they observed 17 cases (1.9%) with aberrant right SCA and none of them had associated variations of the AA. All the cases were asymptomatic and the aberrant right SCA was an incidental observation. In all the cases the aberrant right SCA passed behind the esophagus. C. Matula, S. et al [11] The segment of the vertebral artery that arises from the subclavian to its entry into foramen transversarium is called prevertebral or

pretransverse segment. It is frequently affected by atherosclerosis. Abnormal origin from arch of aorta can cause variations in haemodynamics of cerebral circulation. In the present study a type-III variation of Natsis was found which is clinically significant according to the report by C. Matula et al.

K.S. Satyapal et al [12] in their study on three hundred and twenty aortic arch angiograms found variations in (5.3%). They analysed their results based on primary branches. They noted that (3.4%) had two primary branches, (0.3%) had three primary branches and (1.6%) had four primary branches. They concluded that a variation if clinically silent and is not recognized can have fatal consequences during trauma. One author W. Voster [13] who opined that a variation such as a common trunk for BCT and LCCA may actually be useful clinically during catheterization of LCCA which originates from BCT as there is no need of catheter exchange.

A common trunk for BCT and LCCA, left vertebral artery between the LCCA and LS, absence of common carotid artery, bi-innominate sequence with left coronary artery from the arch of aorta, have all been reported with varying incidences by other authors [14-22].

CONCLUSION

The variation in the arch of aorta is due to involution of some parts of the arterial arches during development. When the right horn of aortic sac disappears before giving rise to the brachiocephalic trunk the part of third aortic arch remains, thus giving rise to a common trunk for both the carotid arteries. Such a variation was noted in this study. In this study the origin of right subclavian artery from the distal part of arch of aorta and passing posterior to esophagus is a significant variation to be noted. The right fourth pharyngeal arch artery and the right dorsal aorta disappear cranial to the seventh intersegmental artery. This results in the formation of right subclavian artery from the right seventh intersegmental artery and distal part of right dorsal aorta. Differential growth shifts the origin of the right subclavian artery cranially close to the left subclavian artery and thus forms a vascular ring behind the trachea and esophagus. In this study it was not present close to the

left subclavian artery but deviated to the right behind the esophagus from the distal part of the arch and did not form a ring. This can have clinically significant symptoms and signs related to pathology in the esophagus or during deglutition.

Conflicts of Interests: None

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