Original Article

Indian Journal of Anatomy
Volume 5 Number 2, May - August 2016
DOI: http://dx.doi.org/10.21088/ija.2320.0022.5216.5

Study on the Variation of Branching Pattern of Arch of Aorta in Cadavers of North Maharashtra

Santosh V. Shinde*, Prashant Bhusari, Dinesh Kathe*, Kushal Shukla***, Karan Khairnar***, Manisha Rajale*****

Abstract

Aims and Objectives: The variations of vessels arising from the aortic arch are numerous. The purpose of this study is the description of the variations on the branching pattern of arch of aorta, in order to offer useful data to anatomists, radiologists, vascular surgeons, neck and thorax surgeons in North Maharashtra subjects, and relating it with embryological basis. *Materials and Methods:* Sixty Six arches of adult North Maharastrian cadavers were exposed and their branches examined during cadaveric dissection in the Department of Anatomy of MVPS Dr. Vasantrao Pawar Medical College, Nashik and PDDVPFs Medical College Ahemadnager, Maharashtra. *Result:* In this investigations three-branched aortic arch was found in 59 cadavers (89.39 %); the 5(7.57 %), remaining aortic arch showed only two branches, out of which one was a common trunk, which incorporated the brachiocephalic trunk and left common carotid and other left subclavian artery and 2(3.03 %) aortic arches showed direct arch origin of the left vertebral artery. *Conclusion:* The accurate information on this is vital for vascular surgery in the thorax, head and neck regions. Although, the variations are usually asymptomatic, they may cause dyspnea, dysphagia, intermittent claudication, misinterpretation of radiological examinations and complications during neck and thorax surgery. These observations are precious while invading the arch of aorta and its branches by instruments, as all areas are susceptible to surgical attack.

Keywords: Thoracic Aorta; Variations; Branches; Vascular Surgery.

Introduction

The arch of the aorta is a continuation of the ascending aorta, located in the superior mediastinum. Three branches – the brachiocephalic trunk, the left common carotid artery, and the left subclavian artery – usually arise from the arch of aorta. The brachiocephalic trunk later divides into the right common carotid and the right subclavian artery (Standring, 2005) [1].

Most of the anomalies of the arch of the aorta and its branches are as a result of an altered development of primitive aortic arches of the embryo during the early gestation period (Nurru et al., 2009) [2].

Author's Affiliation: *Associate Professor, **Professor & Head, ***Assistant Professor, Dept. of Anatomy, MVPS Dr. Vasantrao Pawar Medical College, Nashik – 42200 (Maharashtra).

Corresponding Author: Santosh v. Shinde, Associate Professor, Dept. of Anatomy, MVPS Dr. Vasantrao Pawar Medical College, Nashik – 42200 (Maharashtra).
E-mail: Santoshvshinde15@yahoo.co.in

An understanding of the variability of these arteries remains most important in angiography and surgical procedures where an incomplete knowledge of anatomy can lead to serious implications.

This has become more important in the era of carotid artery stents, vertebral artery stents, and therapeutic options for intracranial interventions (Poonam et al., 2010) [3].

Materials & Methods

Sixty Six arches of adult North Maharastrian cadavers were exposed and their branches examined during cadaveric dissection in the Department of Anatomy of MVPS Dr. Vasantrao Pawar Medical College, Nashik and PDDVPFs Medical College Ahemadnager, Maharashtra.

The dissection of the thoracic region was carried out according to the instructions by Cunningham's Manual of Practical Anatomy (Vol. 2). The dissections took place during the years 2013-2015.

The arteries were allowed to dry and then photographed. Photographs of the variant anatomy of the aortic arch were taken using a digital camera. The variant patterns were tabulated (Table 1).

No additional anomalies or pathological changes were found on the remainder of vessels and other organs of the thoracic cavity of the same cadaver.

Results

In this investigations three-branched aortic arch was found in 59 cadavers (89.39 %); the 2(3.03 %) remaining aortic arch showed only two branches, out of which one was a common trunk, which incorporated the brachiocephalic trunk and left common carotid and other left subclavian artery and 5(7.57 %) aortic arches showed direct arch origin of the left vertebral artery.

The arterial pattern was congregated into three categories based on the frequencies of variations (Vicurevic et al., 2012) [4] (Table 1).

1. *Type I* - 59 cases (89.39%): Normal pattern (Figure 1)
2. *Type II* - 05 cases (07.57%): An aberrant origin of the left vertebral artery (LVA), which showed a typical vessel arrangement (BCT, LCCA, LSA) with the LVA origin between the LCCA and LSA. The left vertebral artery was also arising from the arch of the aorta in addition to the other normal branches (Figure 2).
3. *Type III* - 02 case (3.03%): Only two branches were seen to arise from the arch of the aorta i.e., a common brachiocephalic trunk (CBT), branching into brachiocephalic trunk and left common carotid artery. The LCCA and BCT shared the same site of origin and the LSA was originated from the aortic arch as the most distal branch (Figure 3).

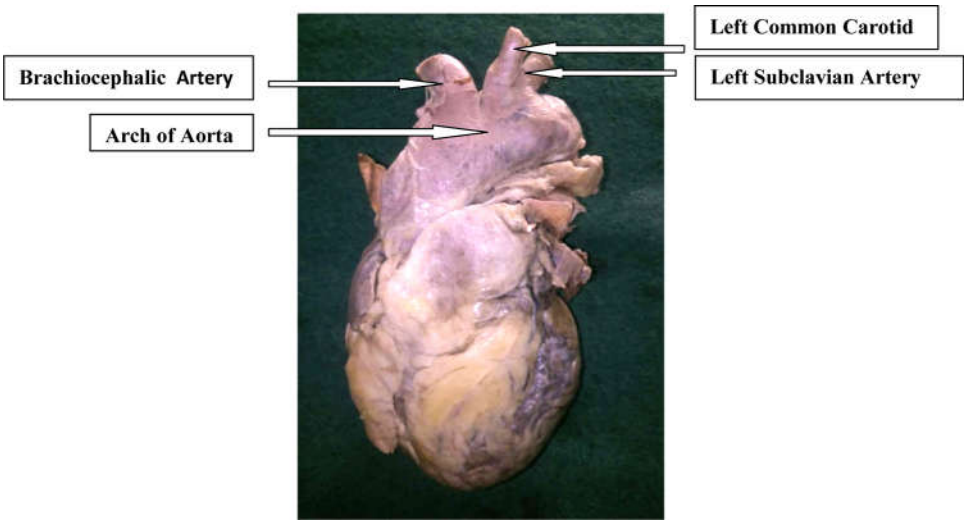

Fig. 1: Arch of aorta shows three branches

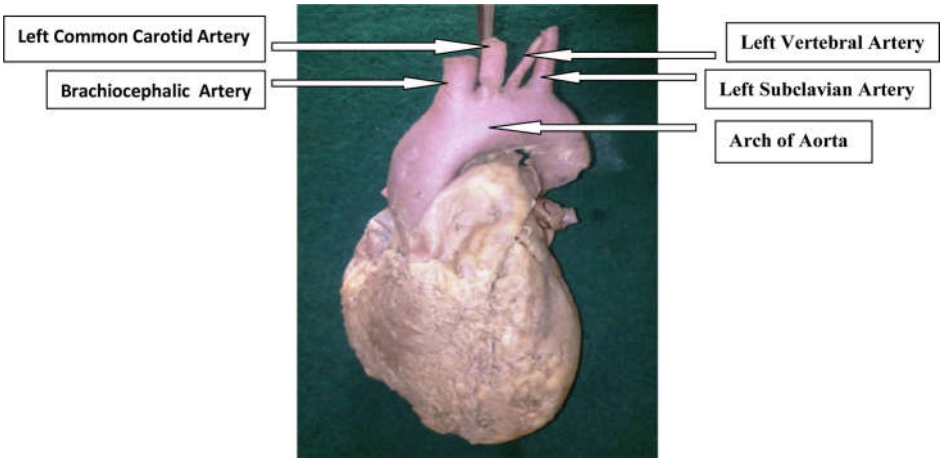

Fig. 2: Arch of aorta shows four branches

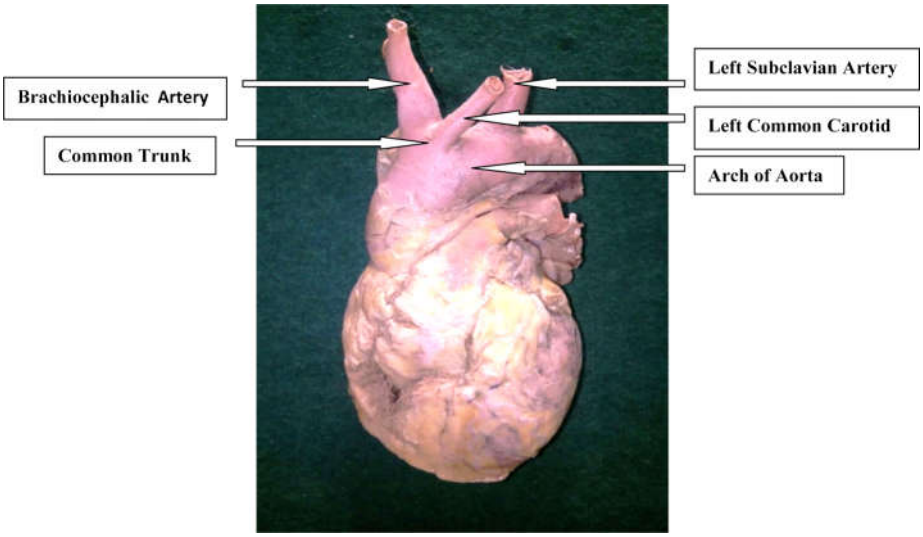

Fig. 3: Arch of aorta shows two branches

Table 1: Types of variations in the arch of aorta

Type	Number of Branches	Description of Branches	Frequency	Percentage (%)
I	3	BCT, LCCA, LSA.	59	89.39 %
II	4	BCT, LCCA, LVA, LSA.	5	7.57 %
II	5	CT (BCT, LCCA), LSA.	2	3.03 %
	Total		66	100 %

BCT (Brachiocephalic Trunk); CBT (Common Brachiocephalic Trunk); LCCA (Left Common Carotid Artery); LSA (Left Subclavian Artery); LVA (Left Vertebral Artery).

Table 2: Incidence of the types of variations in the branching pattern of the arch of aorta

Type	Adachi et al. (1928) (%)	Mc Donald and Anson (1940) (%)	Mc Donald and Anson ((1940) (%)	Mc Donald and Anson ((1940) (%)	Nayak et al. (2006) (%)	Ajit Kumarand Amarnath Mishra *(2015)* %	Present study (%)
I	83.3	66.9	51.7	8.3	91.4	83.33	89.39 %
II	4.3	1.46	---	0.79	1.6	11.90	7.57 %
II	10.9	25.5	41.4	15	4.8	2.38	3.03 %
IV	0.8		1.7	0.16	1.6	2.38	---
	516 Japa-ne	157 American White	59 American Black	633 Greek	62 Indians	42 Nepalese	66 North Maharastrians (indians)

Discussion

Variations of the great arteries in the thoracic region are well known and the aortic arch is one of them. Aortic arch anomalies may also be attributed to chromosomal abnormalities. Momma et al. (1999)[5] noted that aortic arch anomalies are associated with chromosome 22q11 deletion.

The variations of the branches of the arch of the aorta are usually associated with abnormalities of the heart and persistent foetal conditions. Many variations are due to differences in the mode of transformation of aortic arch vessels from the branchial arches, especially from the fourth arch.

Since the aorta and pulmonary artery develops from a common conus arteriosus, irregular and imperfect development of the septum between them may also produce variations (Bergman et al., 1996) [6].

In the present study 59 cases (89.39%) showed a normal branching pattern i.e., the brachiocephalic trunk, the left common carotid artery, and the left subclavian artery and the variations were found in 10.60% of the cases.

These variations are likely to occur as a result of differential development of certain branchial arch arteries during the embryonic period of gestation (Natsis et al., 2009) [7].

The type I arterial arrangement represents the normal branching pattern of the arch of the aorta, reported in 89.39% of the cases. This is in close agreement with the studies have done by various authors (Table 2).

The current study reveals 05 cases (7.57 %) of Type-II pattern i.e., the left vertebral artery arising from the arch of aorta in addition to the other normal branches.

This suggests that part of the arch of the aorta may be arising from the 7th intersegmental artery or may be due to increased absorption of embryonic tissue of the left subclavian artery between the arch of the aorta and the vertebral artery (Moore et al., 2003) [8].

According to Bernardi and Detori, the unusual origin of the vertebral artery may favor cerebral disorders because of alterations in the cerebral hemodynamics (Bernardi et al., 1975) [9].

Such anomalies can cause ischemia, as well as infarction of the brain stem and cerebellum if the vertebro-basilar axis is left dominant and communication at the arterial circle of Willis is poor (Yamashiro et al., 2010)[10].

In this study we observed 02 case (3.03 %) of Type-III pattern i.e., two branches arising from the arch of the aorta, a common brachiocephalic trunk branching into brachiocephalic trunk and left common carotid artery. The left subclavian artery was however arising separately from the arch of the aorta (Figure 3).

The uncommon branching patterns of the aortic arch are due to either persistence of certain aortic arches which should be obliterated normally or viceversa.

The proximal part of the third aortic arch normally gets extended and absorbed into the left horn of the aortic sac. If it gets absorbed into the right horn of the aortic sac, it can lead to anomalies where the left common carotid artery arises from the brachiocephalic trunk or the left horn of the aortic sac is fails to develop (Goray et al., 2005 [11]; Nayak et al., 2006) [12].

There so the left 3rd aortic arch derivatives (LCCA) is directly connected with the right 3rd aortic arch (BCT) or right horn of aortic sac.

Similar reports were documented by Natsis et al. (2009) [7], Paraskevas et al. (2008) [13], Gupta and Sodhi (2005) [14], and Satyapal et al. (2003) [15].

Accidental occlusion of this common trunk may have major ischemic complications given that it supplies both carotids, right vertebral and subclavian arteries.

Conclusion

The wide range of anatomical variations in the branching pattern of aortic arch in North Maharastrians subjects was observed to have three types of variations but the percentage was minimal compared to other regions of populations thereby these variations serve as a valuable tool for a safe endovascular surgeries and angiographies.

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.

Referances

1. Standring S. Gray's Anatomy. 39th ed. Elsevier Churchill Livingstone, Edinburgh. 2005; 1021-1023.
2. Nurru L, Mligiliche, Nithila D Isaac. A three branches aortic arch variant with a bi-carotid trunk and a retro-esophageal right subclavian artery. Int J Anatom Variations. 2009; 2: 11-14.
3. Poonam, Sngla RK, Sharma T. Incident of anomalous origins of vertebral artery – anatomical study and clinical significance. J Clin Diagn Res. 2010; 4(3): 2626-2631.
4. Vicurevic G, Marinkovic S, Puskas L, Kovacevic I, Tanaskovic S, Radakad D, Ilic A. Anatomy and radiology of the variations of aortic arch branches in 1,266 patients. Folia Morphol. 2012; 72(2): 113-122.
5. Momma K, Matsuoka R, Takao A. Aortic arch anomalies associated with chromosome 22q11 deletion (CATCH22). Pediatr Cardiol. 1999; 20: 97-102.
6. Bergman RA, Afifi AK, Miyauchi R. Illustrated encyclopedia of human anatomic variation. 1996. http://www.anatomyatlases.org/Anatomic variants/cardiovascular/Text/Arteries? Aorta. shtml.
7. Natsis KL, Tsitouridis LA, Didagelos MV, Fillipidis AA, Vlasis KG, Tsikaras PD. Anatomical variations in the branches of the human aortic arch in 633 angiographies: clinical significance and literature review. Surg Radiol Anat. 2009; 31: 319-323.
8. Moore K, Persaud TVN. The developing human: Clinically oriented Embryology. Elsevier Science, Philadelphia. 2003; 364-366.
9. Bernardi L, Delttori P. Angiographic study of a rare anomalous origin of the vertebral artery. Neuroradiology. 1975; 9: 43-47.
10. Yamashiro S, Kuniyoshi Y, Arakaki K, Inafuku H, Morishima Y, Kise Y. Total arch replacement with associated anomaly of the left vertebral artery. Ann Thorac Cardiovasc Surg. 2010; 16: 216-219.
11. Goray VB, Joshi AR, Garg A, Merchant S, Yadav B, Ma-Heshwari P. Aortic arch variation: a unique case

with anomalous origin of both vertebral arteries as additional branches of the aortic arch distal to left subclavian artery. Case report. Am J Neuroradiol. 2005; 26: 93-95.

12. Nayak SR, Pai MM, Prabhu LV, D'costa S, Shetty P. Anatomical organization of aortic arch variations in the India: embryological basis and review. J Vasc Bras. 2006; 5: 95-100.
13. 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.
14. Gupta M, Sodhi L. Variations in branching pattern, shape, size and relative distances of arteries arising from arch of aorta. Nepal Med Coll J, 2005; 7: 13-17.
15. Satyapal KS, SS Partab P, Kalideen JM, Robbs JV. Aortic arch branch variations – case report and arteriographic analysis. South African J Surg. 2003; 41(2): 48-50.