

A Study Of The Branching Pattern Of Aortic Arch.

Maheria Pankaj Bhimabhai* , Chaudhari Manisha L**, Guntha Chinna Nagaraju S.***, Parchwani Deepak N.****, Rathod Hitesh K*****.

* Associate Professor Anatomy, GEMRS Medical College, Patan, Gujarat, **Assistant Professor, ***Tutor, Anatomy, ****Associate Professor, Biochemistry, Gujarat Adani Institute of Medical Sciences, Bhuj, Gujarat, ***** Associate Professor, Forensic Medicine GMERS Medical College, Gotri, Vadodara, Gujarat

Abstracts: The purpose of the present study is the description of the aortic arch branches variation in order to offer useful data to anatomists, radiologists, vascular, neck and thorax surgeons. **Methods:** A total 46 Indian adult cadavers were used. The authors investigated anatomical variation of the aortic arch and its major branches. **Results :** The three major branches directly originate from the aortic arch in 38 (82.6 %) ; the 3 (6.5%) remaining aortic arch showed only two branches and 5 (10.9 %) aortic arch showed the direct arch origin of left vertebral artery. **Interpretation & conclusion:** Despite the fact that the variations in question are usually asymptomatic, they may cause dyspnoea, dysphasia, intermittent claudication, misinterpretation of radiology examinations and complications during neck and thorax surgery. This study would provide an anatomical basis to assist surgeons in performing safe vascular surgery involving the aortic arch and its branches.[Maheria P et al NJIRM 2014; 5(1) : 27-30]

Key Words: Aortic arch, Brachiocephalic trunk, Left common carotid artery, Left Ssubclavian artery, Vertebral artery.

Author for correspondence: Maheria Pankaj Bhimabha, 11 Shyam Sundar Society Part III, Vejalpur, Ahmedabad , Gujarat, Phone M: +91 9974742904, E-mail ID: drpankajmaheria@gmail.com

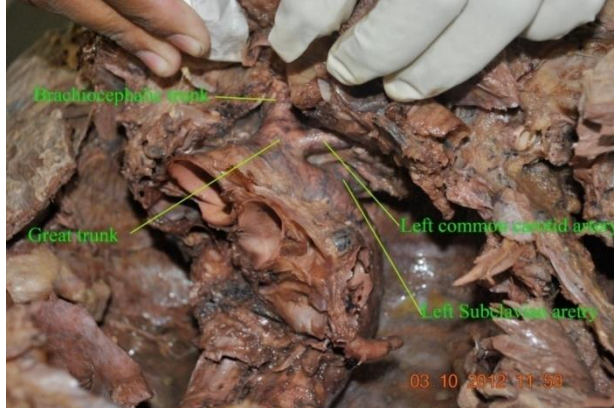
Introduction: The aortic arch continues from the ascending aorta. The aortic arch lies wholly in the superior mediastinum. In about 80.0% of individuals, three branches arise from the arch of the aorta: the brachiocephalic trunk, left common carotid artery, and left subclavian artery. Adachi¹ first classified this branching pattern as Type I. Another 11% have a common trunk incorporating the left common carotid artery and the brachiocephalic trunk leaving only two branches originating from the arch of aorta, Adachi's Type II. The pattern, Type III, has the left vertebral artery, a fourth branch of the arch of aorta, originating proximal to the left subclavian artery . Numerous other variations of the branching pattern of the arch of the aorta are found in less than 1.0% of cases.²

Materials And Methods: This study was carried out between August 2009 to October 2012 on formalin embalmed 46 cadavers out of which 28 were males and 18 females with age ranging from 56 to 98. Procedures for the study were performed by dissection using the regular dissection kit and following the Cunningham's manual of practical anatomy³. The study was analyzed by comparing with normal standard gross origin, courses and branches as stated in the Gray's Anatomy⁴. The variations of the branching pattern of arch of aorta were observed. The study protocol was approved

by the institutional Human Research Ethical Committee.

Results: In the present study, the aorta commenced at the upper part of the left ventricle. After ascending for a short distance, it arched backwards and to the left, over the root of the left lung. Then, it descended on the left side of the thoracic part of the vertebral column. In this study the most common aortic arch branching pattern type I founded in 38 (82.6%) of 46 specimens. In this pattern the three major branches; brachiocephalic trunk, left common carotid, and left subclavian originated independently from the arch of the aorta. Variations from the common pattern of the branches of the arch of aorta were found in 8 cases (17.4%). The following two categories of variations in the branching pattern of the arch of aorta were found: The aortic arch pattern type II was found in 3 specimens (6.5%) which had only 2 great branches. They originated from the upper convex surface of the aortic arch. The first was a common trunk designated the great trunk (GT), which incorporated the brachiocephalic trunk and left common carotid. The second was left subclavian, arising independently distal to the origin of the GT (Fig. 1). In five cadavers (10.9%) an additional artery was noted in addition to the

Fig. 1 : Common origin of brachiocephalic trunk and left common carotid artery from arch of aorta



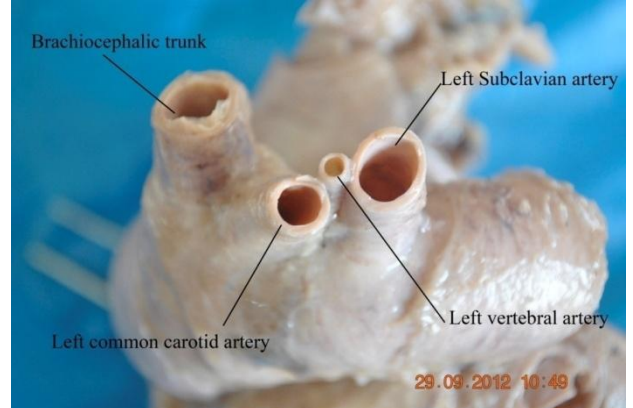
common three branches. The additional branch was traced and found to be the left vertebral artery. It had an independent origin from the aortic arch. It was located between the origins of the left common carotid and the left subclavian arteries. This type was noted as type III. These four branches had their origin from the upper convex surface of the arch. The sequence of the four arteries from the arch, from right to left was brachiocephalic trunk, left common carotid, left vertebral and left subclavian artery (Fig. 2). The details of the types of aortic arch pattern with respect to sex and numbers of cases is given in Table 1.

Table 1 :Showing different types of aortic arches, total and split by sex.

Type	Male	Female	Total	Percentage
Type I	22	16	38	82.61
Type II	2	1	5	10.87
Type III	4	1	3	6.52
Total	28	18	46	100.00

Discussion : Knowledge of variations in the branching pattern of the aortic arch is of great importance in patients who have to undergo for vessel angiography, aortic instrumentation, or supra aortic thoracic, head and neck surgery⁵. The true value of detecting anomalous origins of the branches of the arch of the aorta is the diagnostic gain before vascular surgeries of supraaortic arteries, as variations in the branching pattern of the arch of the aorta are likely to occur as a result of the altered development of certain branchial arch arteries during the embryonic period of gestation.⁶

Fig. 2 :Direct origin of left vertebral artery from arch of aorta



According to Adachi William's Classification¹, in about 80% of individuals, three branches arise from the aortic arch: the brachiocephalic trunk, the left subclavian artery, and the left common carotid artery, described as Type I. 11% of individuals have an Adachi type II pattern, which consists of a common trunk for the left common carotid and the brachiocephalic artery and therefore has only two aortic arch branches. The next most common type, Adachi type III, has a vertebral artery originating proximal to the left subclavian artery as a 4th branch of the aortic arch.

Developmentally, the variations in the branching pattern of the arch of the aorta may be explained as follows- Left limb of aortic sac normally forms the part of the arch of the aorta that intervenes between the origins of the brachiocephalic trunk and the left common carotid artery. If the aortic sac fails to bifurcate into right and left limbs, then the variations in the branching pattern of arch of aorta may occur as observed in the present study. The proximal part of the third aortic arch normally gets extended and absorbed into the left horn of aortic sac. If it gets absorbed right into the horn of the aortic sac, also results the variable branching pattern.^{7,8,9} Momma *et al* described that arch of aorta anomalies is also associated with chromosome 22q11 deletion.¹⁰

Observations of the present study reveal that only 82.6% the aortic arches give these three branches and that variation occurs in 17.4%. Though this is higher than Nayak *et al*¹¹ and Himabindu *et al*¹²; is still less than Gupta *et al*¹³ and Patil ST *et al*.¹⁴

(Table 2). The variant branching pattern is significant to interventional radiologists, anatomists, thoracic and neck surgeons,¹¹ and failure to recognize these patterns may have fatal outcome.¹⁵

Table 2: Proportion of variant branching of aortic arch in different populations.

Author	Population	N	Proportion of aortic arch with variant branching (%)
Gupta and Sodhi (2005)	Indian	100	23
Nayak, Pai, Prabhu et al. (2006)	Indian	61	9.6
Himabindu, Narasinga Rao (2012)	Indian	130	7.7
Patil ST et al (2012)	Indian	75	22.7
Current study (2013)	Indian	46	17.4

The aortic arch gives rise two branches which originated from the upper convex surface of the aortic arch. The first was a common trunk designated the great trunk (GT), which incorporated the brachiocephalic trunk and left common carotid. The second was left subclavian, arising independently distal to the origin of the GT (Fig. 1). Various studies have documented different incidences of this variation. In the present study, it constituted 6.5%, which is higher than Nayak et al¹¹ and Himabindu et al¹²; is still less than Gupta et al¹³ and Patil ST et al¹⁴. (Table 3)

Table 3. Incidence of 2 aortic arch branches in different populations

Author	Population	N	Proportion of aortic arch with variant branching (%)
Gupta and Sodhi (2005)	Indian	100	12
Nayak, Pai, Prabhu et al. (2006)	Indian	61	4.8
Himabindu,	Indian	130	1.5

Narasinga Rao (2012)			
Patil ST et al (2012)	Indian	75	14.66
Current study (2013)	Indian	46	6.5

The third most common variation was that the left vertebral artery arising directly from the aorta., instead of the first part of left subclavian artery. Observation of present study that it arises directly from aortic arch in 10.87 % which is higher than Nayak et al¹¹, Himabindu et al¹² and Patil ST et al¹³ but comparable with Gupta et al¹⁴. (Table. 4)

Table 4: Incidence of vertebral artery from aortic arch.

Author	Population	N	Proportion of aortic arch with variant branching (%)
Gupta and Sodhi (2005)	Indian	100	11
Nayak, Pai, Prabhu et al. (2006)	Indian	61	1.6
Himabindu, Narasinga Rao (2012)	Indian	130	4.6
Patil ST et al (2012)	Indian	75	8
Current study (2013)	Indian	46	10.87

The present study may provide adequate information on the branching pattern of arch of aorta to catheterize the same and its branches for safely performing endovascular surgery. The clinical presentations which these variations give rise to be well known and may present during the first days of life or later in adulthood, or remain clinically silent. Nonrecognition of the latter situation in the presence of vascular trauma may have fatal consequences. Even though the branching patterns of the arch of the aorta are considered to be variants of some deviations of the commonest pattern of development, there were not any noticeable signs of anatomical pathology associated with those variations. These variations have to be taken into consideration by surgeons

when they are planning surgical or diagnostic interventions involving the arch of the aorta and its branches. Surgeons must be aware of possible variations of the major arteries and be able to identify them. Correct identification of these vessels is very important for appropriate invasive techniques in order to achieve desired objectives and to avoid major complications especially during vascular surgery. The anatomic and morphological variations of the arch of the aorta and its branches are significant for diagnostic and surgical procedures in the thorax and neck.

Conclusion : The present study shown that approximantly 18% of the subject have a non normnal anatomy of aortic branches. Anomalous origins of the aortic arch branches are merely anatomic variants, accurate information about them is vital for vascular surgery in the thorax, head and neck region.

References

1. Adachi B. Das arteriensystem der Japaner. In: Kyoto editor. Verlag der Kaiserlich- Japanischen Universitat, Vol .1 Kenyusha Press 1928.p.29-41.
2. Bergman RA, Afifi AK, Miyauchi R. Illustrated encyclopedia of human anatomic ariation(online) Available: <http://www.vh.org/Providers/Textbooks/AnatomicVariants/CardiovascularText/Arteries/Aorta.html>. 2000:1-35.
3. Romanes GJ., Cunningham's Manual of practical anatomy 15th edition Vol. 2 Oxford medical publications;2005.p.57-62
4. Standring S, Borley NR, Collins P, Crossman AR, Gatzoulis MA, Healy JC, et al. Thorax. In: editor. Gray's Anatomy. 40th ed. Newyork: Elsevier Churchill Livingston; 2008.p.984-5.
5. Natsis KI, Tsiouridis IA, 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;31:319-23.
6. Bhatia K, Ghabriel MN, Henneberg M. Anatomical variations in the branches the human aortic arch: a recent study of a South Australian population. Folia Morphol 2005;64:217-23.
7. Moore KL, Persaud TVN. Cardiovascular system. In: Moore KL, Persaud TVN, editors. The developing human: Clinically oriented embryology. 8th ed. Philadelphia: Saunders Elsevier;2008.p.305-25.
8. Sadler TW. Cardiovascular system. In: Sadler TW, editor. Langman's Medical Embryology.10th eEd. Philadelphia: Lippincott Williams & Wilkins;2006.p.173 -85.
9. Larsen WJ. Development of vasculature. In: Larsen WJ, Sherman LS, Potter SS et al editors. Human mbryology.3rded. Philadelphia: Churchill Livingstone 2001;199-204.
10. Momma K, Matsuoka R, Takao A. Aortic arch anomalies associated with chromosome 22q11 deletion (CATCH 22). Pediatr Cardiol 1999;20:97-102.
11. Nayak SR, Pai MM., Prabhu LV., D'costa, S. Shetty P. Anatomical organization of aortic arch variations in India; embryological basis and review. Jornal Vascular Brasileiro 2006;5:95-100.
12. Himabindu , Rao N. Variation of aortic arch branches in full term fetuses. NJBMS 2012;3:99-102.
13. Gupta M, Sodhi L. Variations in branching pattern, shape, size and relative distances of arteries arising from arch of aorta. Nepal Medical College Journal 2005;7:13-7.
14. Patil ST, Meshram MM, Kamdi NY, Kasote AP, Parchand MP. Study on branching pattern of aortic arch in Indian. Anat Cell Biol 2012;45(3):203-6.
15. Satyapal KS, Partab SS, Kalideen P, and Robbs JV. Aortic arch branch variations – case report and arteriographic analysis. South African Journal of Surgery 2003;41:48-50.

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