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A Study on Variations in Branching Pattern of Aortic Arch in the Human Fetuses and Its Clinical Significance

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Abstract: *Anatomical variations in the branching pattern of aortic arch arise as a result of altered development of primitive aortic arch associated with ''migration'' and ''merging'' of arch branches during early gestational period. The present study is conducted on branching pattern of aortic arch in the aborted human fetuses, as the literature regarding the fetuses is very limited.* ***Aim****: To study the variations in branching pattern of aortic arch in the human fetuses.* ***Material and methods:*** *The present study is conducted on 120 aborted human fetuses of both sexes between 18 – 38-week gestational age groups collected from Government Maternity hospital, Tirupati and preserved in Anatomy department, SVMC, Tirupati. After 1 week of preservation in 10% formalin the thorax was opened and observed the branching pattern of aortic arch.* ***Results****: Variations in branching pattern of aortic arch were observed and categorized into 3 groups, Type I - Classical or normal branching pattern (91.66%), Type III - Direct origin of left vertebral artery from aortic arch (5%), Type IV- Common trunk for BCT & LCCA and direct origin of left vertebral artery from aortic arch between common trunk and left subclavian artery (3.33%) which is a rare anomaly.* ***Conclusion:*** *In pediatric cardiovascular surgeries like repair of patent ductus arteriosus (PDA), truncus arteriosus, transposition of great vessels, coarctation of aorta (COA), aortic interruption surgeons should be aware of aortic arch branching variations.*

Key words: *Aortic arch, Fetus, Left vertebral artery, Variations.*

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I. Introduction:

Cardiovascular system is one of the first systems to develop in the human embryo for the transport of oxygen. Aorta begins at the aortic orifice of the left ventricle of the heart and ascends as the ascending aorta in the superior mediastinum approximately 5cm to the sternal angle where it continues as arch of the aorta and three major branches 1. Right brachiocephalic trunk 2. Left common carotid artery and 3. Left subclavian artery arise from the convexity of arch in approximately 65% of the individuals. [1] Aortic arch anomalies are associated with chromosome 22 q 11 del (Momma et al 1999). [2] According to Adachi 1928, Anson 1971, Roguin 1982, Testut 1948, number of primary branches may be reduced to 1-2 or increased 4-6. [3] Unusual patterns of development of embryonic arterial arch system leads to aortic arch anomalies. [4] The common sharing of brachiocephalic trunk and left common carotid artery may be a marker for presence of accompanying congenital cardiac and coronary artery anomalies. [5]Bernardi et al 1975 hypothesized that anomalous origins and distribution of large aortic arch vessels causes changes in cerebral haemodynamics that may lead to cerebrovascular catastrophies.[6] Knowledge of variations in branching pattern of aortic arch is essential for surgeons, radiologists and clinicians for diagnosis and in safe performance of procedures like aortic instrumentation, angiography, non-invasive procedures of neck, supra aortic, thoracic, head and neck surgeries to prevent major vascular complications during surgical procedures.

II. Materials And Methods:

The present study is conducted in the department of Anatomy, S.V.Medical College, with the cooperation of Government Maternity Hospital, Tirupati. The ethical committee approval and the written consent from the family members of aborted fetuses collected were also obtained. Fetus with congenital anomalies are excluded; Obstretic data and foetal external parameters were recorded. After 1 week of preservation in 10% formalin the thorax was opened by cunninghams manual dissection method, thymus and

pericardium were removed and brachiocephalic veins were cut, then aortic arch and its branches were traced to find out whether the branching pattern is normal or abnormal.

III. Results:

120 aborted fetuses were dissected and studied with respect to branches arising from arch of aorta and the specimens were divided into various types based on Anson's classification (11). In the present study, three types of branching pattern were observed. (Table 1)

Type I – aortic arch with three branches – brachiocephalic trunk, left common carotid and left subclavian arteries (Figure-1).

Type III - left vertebral artery as an additional branch from the arch in between the origins of left common carotid artery and left subclavian artery (Figure -2).

Type IV – common trunk for BCT and LCCA and left vertebral artery from the arch in between the origin of LCCA and LSCA (Figure-3)

Table – 1: Classification of branching pattern of aortic arch in 120 aborted fetuses

Type of Anomaly	No of branches	No of specimens	Frequency%
I	3	110	91.66%
III	4	6	5%
IV	3	4	3.33%

Fig 1: Type-I Classical or Normal branching pattern of AA

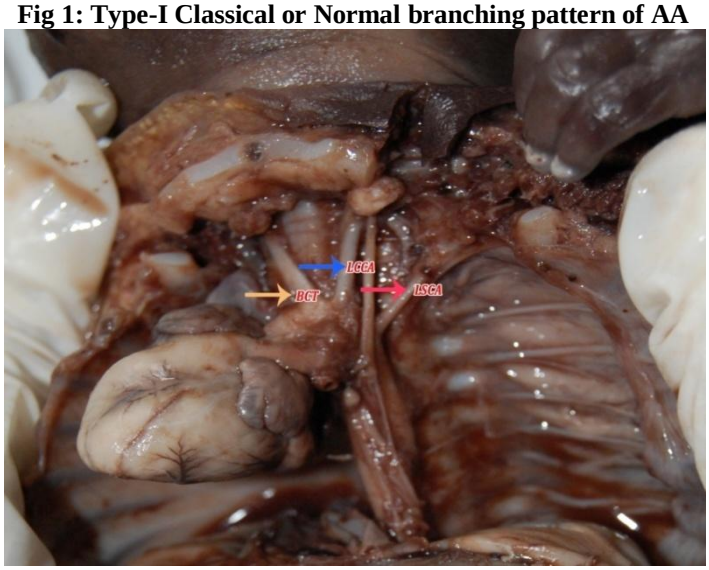


Fig 2: Type-III LVA arising from aortic arch in between LCCA & LSCA

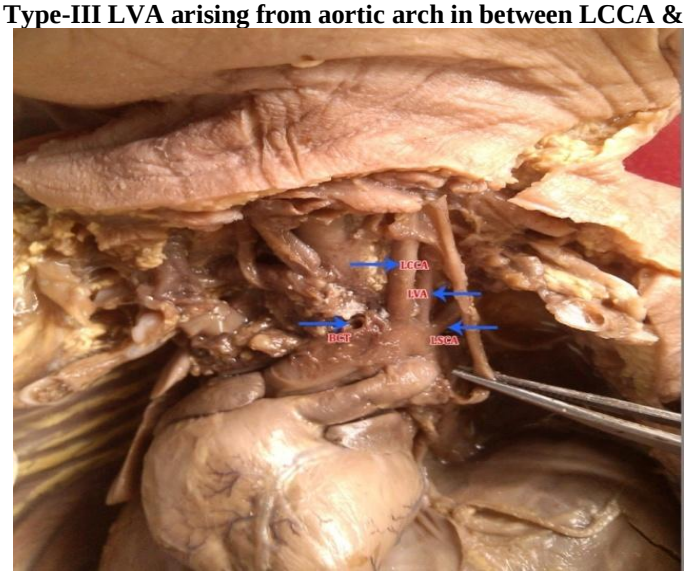
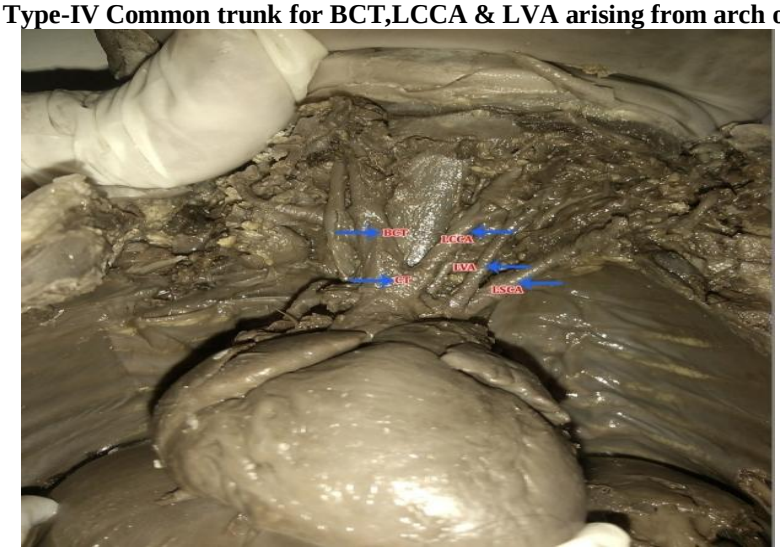


Fig 3: Type-IV Common trunk for BCT,LCCA & LVA arising from arch of aorta



IV. Discussion:

Development of aorta takes place during third week of gestation.[7] It is a complex process associated with the formation of the endocardial tube (day 21). Each primitive aorta consists of a ventral and a dorsal segment which are continuous with the first aortic arch. The two ventral aortae fuse to form aortic sac. The dorsal aortae fuse in midline to form the descending aorta. Six pairs of aortic arches also called branchial arch arteries develop between the ventral and dorsal aortae. In additionthe dorsal aorta gives off several intersegmental arteries.During the sixth to eighth week of gestation, the six aortic arches along with the seventh segmental dorsal artery from each dorsal aorta develop into the aortic arch and its major branches.In human embryos, all the aortic arches were never appear at the same time. Their formation and remodelling (with the exception of the fifth arch) shows pronounced craniocaudal sequence.[8] The more cranial are in the process of regression before the caudal ones are completed.

The proximal portion of aortic arch is derived from the left horn of aortic sac and the distal portion is derived from left dorsal aorta. The arch of aorta between left common carotid and left subclavian arteries is derived from the left fourth aortic arch. [9] The brachiocephalic artery is derived from the right horn of aortic sac. The proximal segment of right subclavian artery is derived from right fourth aortic arch and its distal part from a portion of right dorsal aorta and seventh cervical intersegmentalartery.The left subclavian artery is derived from left seventh cervical intersegmental artery.The proximal parts of the third pair of aortic arches form the common carotid arteries. Vertebral artery is formed by the development of longitudinal anastamoses that connects the dorsal cervical intersegmental arteries.

Most common branching pattern in humans are three great vessels originating from the arch of aorta--right brachiocephalic trunk, left common carotid artery and left subclavian artery. Variations of branches at the origin of aortic arch were due to defective development of aorticopulmonary septum of the truncus arteriosus.[10] More than 15 different aortic arch configurations have been described by Anson.[11] In 2007 Komiyama et al[12] retrospectively examined the angiograms of 1109 patients to evaluate arterial dissection of intracranial or extracranial vertebral arteries and the origin of vertebral artery from the aorta or subclavian artery. They concluded that left vertebral artery of aortic origin is associated with a predilection for vertebral artery dissection in comparison to left vertebral artery of subclavian artery origin. Shear stress may be larger in the vertebral artery of aortic origin than in the vertebral artery of subclavian artery origin due to anatomical differences.

The frequency of various types of branching pattern of the aortic arch in previous studies and the present study were compared in table 2.

Table 2: Comparison of branching pattern of aortic arch with previous studies

S.NO	Author	Year	Sample no	Type I	Type III	Type IV
1	Jerzy et al[13]	2004	103	80.06%	6.80%	---
2	Michal Szpinda[14]	2005	131	74.05%	5.34%	---
3	A.Himabindu et al[15]	2012	130	92%	4.60%	---

4	V.Sunitha[4]	2012	150	73.30%	4%	2.66%
5	Present study	2020	120	91.66%	5%	3.33%

Jerzy et al[13] who conducted study on 103 human fetuses identified, 3 main branches Viz; BCT, LCC and LSCA originating directly from the aortic arch in 80.6 % cases (Type I) and origin of left vertebral artery directly from the aortic arch between the left common carotid artery and left subclavian artery in 6.8 % cases (Type III).

Michal Szpinda et al[14] worked on 131 human fetuses and identified normal branching pattern in 74.05% cases (Type I) and direct origin of left vertebral artery from aortic arch in 5.34% cases (Type III).

A. Himabindu et al [15] in their study on 130 human fetuses, observed classical branching pattern of brachiocephalic trunk, left common carotid artery, and left subclavian artery from aortic arch in 92 % fetuses (type I). The additional branch left vertebral artery arise directly from the upper convex surface of arch of aorta in between the origins of left common carotid artery and left subclavian artery in 4.6 % cases (Type III).

V. Sunitha (4) conducted study in 150 stillborn fetuses and observed the normal branching pattern in 73.3 % cases (Type I). The numbers of branches were increased to 4 with the origin of left vertebral artery directly from aortic arch in between the left common carotid and left subclavian artery in 4 % cases (Type III). In 2.66% cases there is origin of common trunk for BCT and LCCA and left vertebral artery directly from the aortic arch in between common trunk and LSCA.

The present results were nearly similar to that of various authors like A. Himabindu et al [15] regarding percentage incidence of type I pattern. Percentage of type III anomaly was correlated with nearly similar results in the literature. [13 -15] Incidence of type IV anomaly was in agreement with the results reported in literature by V.Sunitha.[4]

V. Conclusion:

Knowledge of the various anomalies of aortic arch and its major branches is important to clinician, surgeon and radiologist as they are associated with other congenital anomalies such as tetralogy of Fallot (TOF),[16,17]tricuspid atresia, transposition of great vessels, ventricular septal defect,[18] tracheo - oesophagial fistula, patent ductus arteriosus,[19] anomalous right recurrent branch of vagus and right thoracic duct.[20]

Contribution details: Experimentation, compilation of data and original writing.

Conflicts of interest: There are no conflicts of interest.

References:

[1]. Paraskevas G, Agios P, Stavrakas M, Stoltidou A, Tzaveas A, Left common carotid artery arising from the brachiocephalic trunk: a case report. Cases Journal 2008; 1(1): 83.

[2]. Momma K, Matsuoka R, Takao A. Aortic arch anomalies associated with chromosome 22q11 deletion (CATCH 22).Pediatric Cardiology 1999;20(2):97-102. (cited by Haifa A.Alsaif (2010).

[3]. Anson BI. Thoracic cavity and its contents. In: Anson BI, McVay Ch (eds). Surgical anatomy 1 W.B.Saunders Company, Philadelphia, London, Toronto 1971; 408-412. (cited V.Sunitha 2012).

[4]. Sunitha V.A Study of Aortic arch in the human fetuses of North coastal Andhra Pradesh 2012 Vol. 2 (1) January-April, pp. 196-200.

[5]. Moskowitz WB, Topaz On. The implications of common brachiocephalic trunk on associated congenital cardiovascular defects and their management. Cardiology in the Young 2003;13(6):537-543.

[6]. Bernardi L, Deton P. Angiographic study of a rare anomalous origin of the vertebral artery. Neuroradiology-9 1975; 43-47

[7]. Schleich J M. Images in cardiology – development of the human heart: days 15-21. Heart 2002; May; 87(5):487

[8]. Carlson BM. Human embryology and developmental biology. 3rd edition. Philadelphia: Mosby; 2004. P.436 – 75

[9]. Datta A.K Essentials of human embryology. 6thedn. Kolkata: current book International; 2010. P174-81.

[10]. Mligiliche NL and Issac ND. A three branched aortic arch variant with a bicarotid trunk and a retrooesophageal right subclavian artery. International journal of Anatomical variations; 2009; vol 2, p.11-14

[11]. Liechty, Shields, and Anson. Variation in branching of aortic arches. Quart. Bull. Northwest Univ. Med Sch.1957;31: 136-143.

[12]. Komiyama M, Morikawa T, Nakajima H, Nishikawa M, Yasui T. High incidence of arterial dissection associated with left vertebral artery of aortic origin. Neurologia medica- chirurgica; 2001; 41:8-12.

[13]. .Jerzy St Gielecki, Renata wilk, BozenaSyc, Magdalena Musial-Kopiejka, AnetaPiwowarczyk - NowakDigital – image analysis of the aortic arch's development and its variations. Folia morphol.2004; vol 63, No. 4, pp. 449-454.

[14]. Michal Szpinda, Piotr Flisinki, Gabriela Elminowska-Wenda, Mariusz Flisinki et al –The variability and morphometry of the brachiocephalic trunk in human foetuses.Folia Morphologica. 2005vol 64, No 4 pp309-314.

[15]. Himabindhu.A, NarasingaRao.B. Variations of aortic arch branches in full term fetuses. National journal of basic medical sciences. 2012; volume – III, issue -2.

[16]. Backer CL. Compression of the trachea by vascular rings. In: Shields TW, LoCicero J, Ponn RB, editors. General thoracic surgery. 5th ed. Philadelphia: Lippincott Williams & Wilkins;2000.

[17]. D'Cruz IA, Cantez T, Namin EP, Licata R, Hastreiter AR. Right aortic arch , right descending aorta and associated anomalies. Brit Heart J.1966: 28:725-39.

[18]. Hastreiter AR, D'Cruz IA, Cantez T. Occurrence of right aortic arch in various types of congenital heart disease. Brit. Heart J.1966; 28:722-25.

[19]. Blades B, editor.Surgical diseases of the chest. St.Louis: Mosby; 1961 p.429 – 95.

[20]. Cakirer S, Karaarslan E. Aortic arch origin of the left external carotid artery. Am J Neuroradiol.2003; 24: 1492.