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Original Article

Branching Patterns and Anatomical Variations of the Arch of the Aorta in Indian Subjects: A Cadaveric Study

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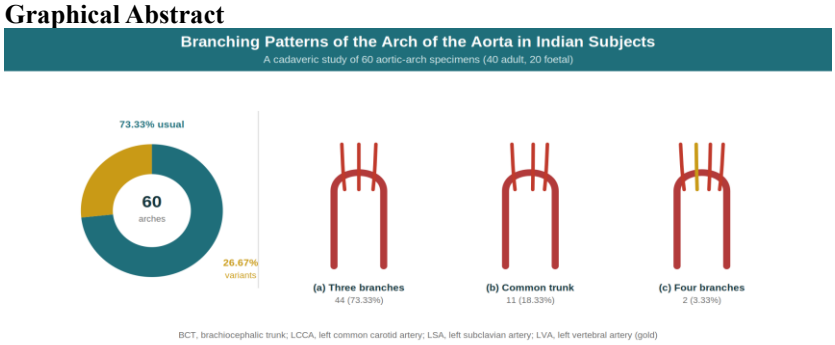
ABSTRACT

Knowledge of the aortic-arch branching pattern is important during supra-aortic angiography, aortic instrumentation, and thoracic and neck surgery. This study describes the branching pattern and morphometry of the arch of the aorta in Indian subjects. Sixty aortic-arch specimens (40 from adult cadavers and 20 from still-born foetuses) were examined by cadaveric dissection. The usual three-branched pattern—the brachiocephalic trunk, left common carotid artery, and left subclavian artery—was found in 44 specimens (73.33%), and variations in 16 specimens (26.67%). A common brachiocephalic–left common carotid trunk (two-branched arch) occurred in 11 specimens (18.33%), a four-branched arch in 2 specimens (3.33%), and three further variant types in the remaining 3 specimens (5.00%). The mean diameters of the brachiocephalic trunk, left common carotid, and left subclavian arteries were 13.57, 8.27, and 11.46 mm, respectively. The wide spectrum of variation in the human aortic arch is relevant to safe catheterisation during endovascular procedures and to surgery of the thorax, head, and neck.

Graphical Abstract



Keywords*: aortic arch; branching pattern; anatomical variation; brachiocephalic trunk; cadaveric study.*

INTRODUCTION

The aorta is the main arterial trunk of the systemic circulation. It is divided into the ascending aorta, the arch of the aorta, and the descending aorta, the last being further divided into thoracic and abdominal parts. Three branches usually arise from the convex superior aspect of the arch: the brachiocephalic trunk (BCT), the left common carotid artery (LCCA), and the left subclavian artery (LSA) (Williams et al., 1995). Variations in the branching pattern range from differences in the distance between the origins of the branches to differences in their number, and are significant for diagnostic and surgical

procedures in the thorax and neck (Natsis et al., 2009). The present study describes the branching pattern of the arch of the aorta in Indian cadavers and discusses the findings and their clinical implications.

MATERIALS AND METHODS

Sixty aortic-arch specimens were studied: 39 adult aortic-arch specimens and one pre-dissected adult heart with the aortic arch en bloc (40 adult specimens in total), together with 20 heart specimens with the aortic arch en bloc obtained from still-born foetuses. The thoracic cavity was opened and the superior mediastinum exposed; the fat and pericardium covering the ascending aorta and great vessels were removed. The branching pattern, the diameter of each branch at its origin, and the distance of each branch origin from the median plane were recorded with digital Vernier callipers, and photographs were taken. Data were analysed descriptively using SPSS version 20. Institutional ethical clearance was obtained.

RESULTS

The usual pattern of three branches arising directly from the arch was observed in 44 specimens (73.33%). Variations were present in the remaining 16 specimens (26.67%), comprising five types (Table 1). A common trunk for the BCT and LCCA was the commonest variant (11 specimens, 18.33%); a four-branched arch was found in 2 specimens (3.33%); and three further variant types were each observed in a single specimen (1.67% each). The observed patterns are illustrated in Figure 1.

Table 1. Branching pattern of the arch of the aorta in 60 specimens.

Branching pattern	Branches	n	%
Usual pattern (BCT, LCCA, LSA)	3	44	73.33
Common BCT + LCCA trunk	2	11	18.33
Four-branched arch	4	2	3.33
Three other variant	—	3	5.00
Total		**60**	**100**

BCT, brachiocephalic trunk; LCCA, left common carotid artery; LSA, left subclavian artery.

The mean distances of the branch origins from the median plane and the mean diameters of the branches at their origins are given in Table 2. The origins lay progressively further to the left in the order BCT, LCCA, LSA, and the BCT was the widest of the three branches.

Table 2. Morphometry of the aortic-arch branches (mean ± SD).

Parameter	Side	Mean ± SD (mm)
Brachiocephalic trunk)BCT(— distance	Left	1.58 ± 3.88
Brachiocephalic trunk)BCT(— distance	Right	1.00 ± 3.41
Left common carotid artery — distance	Left	3.13 ± 13.44
Left subclavian artery — distance	Left	3.39 ± 24.29
Common trunk)BCT + LCCA(— distance	Left	5.64 ± 6.25
Common trunk)BCT + LCCA(— distance	Right	1.27 ± 3.80
Left vertebral artery — distance	Left	6.78 ± 21.22
Brachiocephalic trunk)BCT(— diameter	—	1.59 ± 13.57
Left common carotid artery — diameter	—	0.89 ± 8.27
Left subclavian artery — diameter	—	1.20 ± 11.46

Morphometric measurements pertain to the adult specimens; the left and right values for the BCT and common trunk denote the margins of the origin.

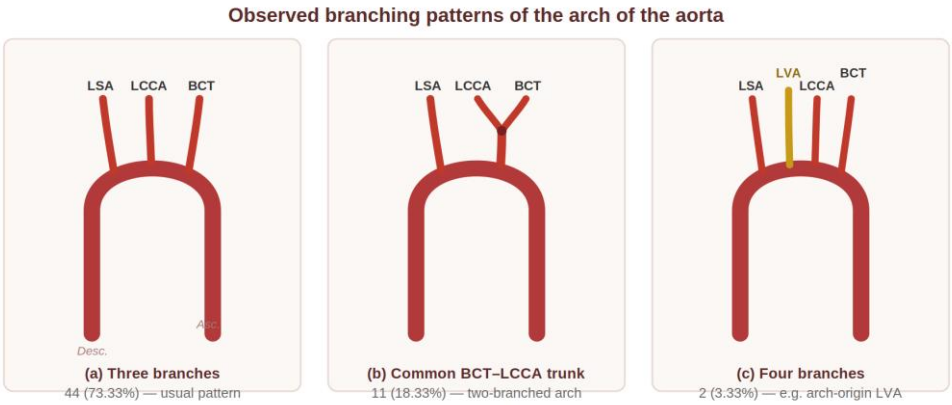


Figure 1. Observed branching patterns of the arch of the aorta: (a) usual three-branched arch; (b) common brachiocephalic–left common carotid trunk; (c) four-branched arch (e.g., arch-origin left vertebral artery).

DISCUSSION

The branching pattern of the aortic arch varies across populations. A common origin of the carotid arteries (the "bovine" arch) is a recognised variant, reported in approximately 11% of white subjects and up to 25% of the African-American population (Williams & Edmonds, 1936). The usual three-branched pattern here (73.33%) is comparable with Patil et al. (2012) on 75 Indian cadavers (77.33% three-branched, 14.66% two-branched), and in keeping with Jakanani et al. (2010), Vucurevic et al. (2013), and Vinnakota and Bhattam (2012); morphometric values are broadly consistent with earlier reports (Kumar et al., 2012; Shin et al., 2008). The common-trunk pattern (18.33%) is of particular relevance to supra-aortic instrumentation.

Limitations. The sample combined 40 adult with 20 still-born foetal specimens; morphometry was derived from the adult specimens, and the two groups are best reported separately. Several variant subgroups contained only one or two specimens, so their percentages carry wide uncertainty. The study was descriptive and single-centre.

CONCLUSION

This cadaveric study provides useful information on the branching pattern and morphometry of the arch of the aorta in Indian subjects. The range of variation was comparable with that reported in other populations, and these variations should be borne in mind during vascular surgery and endovascular investigation of the thorax, head, and neck.

DECLARATIONS

Ethical approval: Institutional ethical clearance was obtained.
Source of funding: None.
Conflict of interest: The authors declare no conflict of interest.

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