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Aortic enlargement: a case report of cadaveric heart and great vessels dimensions



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ABSTRACT

Aortic enlargement is not an uncommon incidental finding with potential omission of clinical implications. During routine dissection in the middle of the thorax, there was an incidental finding of a disproportionately enlarged aorta in comparison to normal-sized heart at gross observation despite normal anatomy in local and

adjacent structures. Incidental finding of aortic enlargement should not be disregarded as it might contribute to pathological processes. The use of indices could give a more comprehensive appraisal of cardiovascular system dimensions.

Keywords: aortic enlargement, heart, great vessels, dimension, cadaver

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INTRODUCTION

The aorta serves as a main artery in the body owing to its large size and direct extension from the heart. Along its course through the thorax down to the abdomen it changes in three different orientations and is subdivided into three sections thereof, namely ascending aorta, aortic arch (AA), and descending aorta. Three vessels originating from superior convex part of the arch are brachiocephalic artery (BCA), left common carotid artery (LCCA), and left subclavian artery (LSCA) – which are collectively referred to as the great vessels. Towards the left and posterior of aorta lies another cardiac outflow tract named pulmonary artery, which bifurcates below the AA and enter each side of the lungs.¹⁻³

Apart from normal anatomical variants, pathological processes resulting from early developmental errors or acquired changes later in life could lead to anomalous morphology of these vessels. Aortic enlargement is not an uncommon incidental finding with potential omission of clinical implications. Although the risk of aortic dilatation per se remains an enigma, once progression to aneurysm occurs, it could lead to acute fatal consequences.⁴⁻⁶ This present study describes a rare cadaveric finding of aortic enlargement along with heart and great vessels dimensions.

CASE REPORT

During routine dissection in the middle of the thorax, there was an incidental finding of a disproportionately enlarged aorta in comparison to normal-sized heart at gross observation. The heart along with its great vessels were fixed using 10% formalin. This specimen was obtained from a fresh-frozen male Indonesian cadaver whose age at death was 36 years old.

External cardiac dimensions were presented in [Figure 1](#). Heart length and width were 91.8 mm and 85.4 mm, respectively. Heart length index of 93.03 was calculated as the percentage of heart width/heart length.

Aortic size seemed to exceed the normal proportion compared with the heart as shown in the frontal and antero-frontal view. The whole structures of aorta including aortic root, ascending aorta, aortic arch, and descending aorta were expanded thoroughly ([Figure 2](#)).

Dimensions of the great vessels were provided in [Table 1](#). Overall (96.95) and middle (27.08) aortic arch indices were calculated by these following two formulas, respectively: (aortic arch length/heart length*100) and (diameter of middle part of the aortic arch/length of the aortic arch*100).

DISCUSSION

Existing works of literature attempting to establish

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normal reference of heart and great vessels dimensions in postmortem setting were relatively scant. In the recent *Gray's anatomy* textbook it was cited that the average adult heart length and transverse diameter were 12 cm and 8-9 cm, respectively.⁷ A large scale cadaveric study on normal heart size involving 550 cadavers of Iranian

population revealed a wider reference range of heart length (11.41 ± 2.15 cm) and width (8.21 ± 4.38 cm). Specific mean heart length (11.89 ± 1.60 cm) and width (8.98 ± 7.17 cm) for matching age group (30-39 years) were provided for more accurate comparison with the current study.⁸ Former similar study in adult Bangladeshi decedents further specified the mean length and width for each gender. Male mean heart length (10.5 ± 0.62 cm) and width (8.51 ± 0.61) were more prominent than the female counterpart.⁹ Heart width in current study was well within aforementioned reference ranges, while the length was below all the references.

The previous study by Redheuil et al. involving aortic arch length measurement was done using magnetic resonance imaging on a general population study sample who were free of overt cardiovascular disease. Reported mean aortic arch length for male was 122 ± 21 mm. Despite its original aim in studying age-related changes in aortic arch geometry, the result was deemed comparable as the male patients had a mean age of 45 ± 15 years.¹⁰ Two other studies assessed aortic arch diameter similarly using computed tomography (CT) in both living cohort and cadavers. American College of Radiology aimed to establish normative reference values for aortic diameter as a part of a trial (National Lung Screening Trial) which include lung cancer patients. The mean diameter in axial (2.78 ± 0.29 cm) and sagittal oblique (2.73 ± 0.28 cm) CT was obtained.¹¹ An anatomical study by Aboulhoda et al. in ten adult Egyptian cadavers found mean outer aortic arch diameter of 33.83 ± 4.03 mm proximally and 22.06 ± 2.77 mm distally.¹² Preceding absolute measurement parameters of aortic arch were proven to be larger than that of this decedent, however we highlight the importance to take relative measurement as indices into account.

In an attempt to construct a comprehensive comparison of heart and great vessels dimensions, indices value intervals were generated from the combination of available age and gender specified normal reference ranges. Based on similar studies,^{8,9} the range of heart length (9.88-13.49 cm) and width (7.9-9.12 cm) were obtained, yielding heart length index value of 58.56-92.31. Additional precaution by truncating standard deviation value was taken when interpreting age-specific heart width from previous study as the range was considerably wide. Similarly, aortic arc length range (10.1-14.3 cm) extracted from the study by Redheuil et al.¹⁰ resulted in overall aortic arch index value of 74.87-144.74. Interval range for the middle aortic arch index of 17.13-31.09 was derived from two prior studies.¹¹⁻¹² Indices from this study were greater than secondarily derived reference values of past studies.

Table 1. Dimensions of the great arteries.

Parameters	Measurement results (mm)
Length of AA	89.0
External diameter of proximal BCA	15.2
External diameter of proximal PA	28.0
Diameter of middle AA	24.1
Diameter of distal AA	17.5
External diameter of proximal LCCA	7.9
Internal diameter of proximal LCCA	6.0
External diameter of proximal LSCA	11.7
Internal diameter of proximal LSCA	9.5

AA: aortic arch; BCA: brachiocephalic artery; LCCA: left common carotid artery; LSCA: left subclavian artery; PA: pulmonary artery.

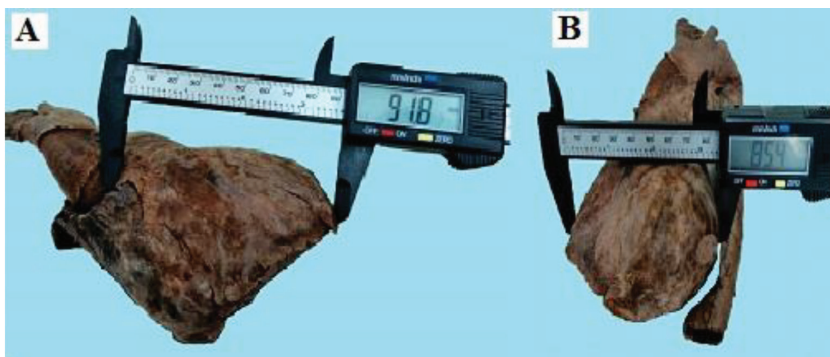


Figure 1. External cardiac dimensions. (A) Heart length measured 91.8 mm. (B) Heart width measured 85.4 mm.

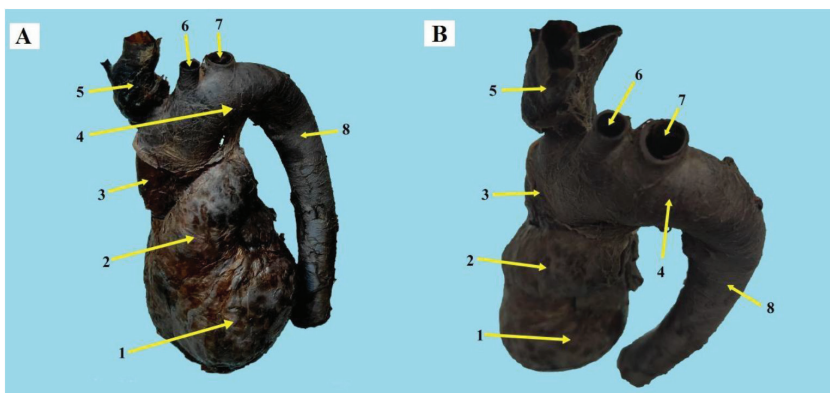


Figure 2. Photograph of the heart with surrounding great vessels. (A) Frontal view. (B) Antero-frontal view. 1, ventricle; 2, atrium; 3, ascending aorta; 4, aortic arch; 5, ascending aorta; 6, left common carotid artery; 7, left subclavian artery; 8, descending thoracic aorta.

A cadaveric investigation of great vessels morphology in Korean adults investigated mean internal diameters of BCA (18.3 ± 7.0 mm), LCCA (9.8 ± 1.9), and LSCA (10.6 ± 2.4).¹³ Measurements of the outer diameter of BCA (15.7 ± 7.42 mm), LCCA (11.42 ± 4.72 mm), and LSCA (14.02 ± 6.8 mm) were also found by Aboulhoda et al.¹² Mean external diameters of BCA (18.0 ± 3.8 mm), LCCA (12.6 ± 2.7 mm), and LSCA (14.1 ± 2.5 mm) were measured by CT aortograms in over a hundred of Asian patients without previous open surgery or endovascular treatment of the thoracic aorta.¹⁴ Comparable internal and external diameters were found in this report except for smaller internal LCCA diameter.

In contrast to other dimensions of interest, pulmonary artery diameter was more rigorously researched and therefore had fixed normative value established. Both studies covered in this topic used CT as their imaging modality, but the main difference lies in the study population recruited. An earlier study in healthy adults showed mean PA diameter of 24.0 ± 2.8 mm without significant gender difference.¹⁵ While later study as a part of community-based Framingham Heart Study revealed comparable diameter (25.1 ± 2.8 mm), more straightforward gender-specific normative reference was determined for men (29 mm) and women (27 mm).¹⁶ These results confirmed a normal PA size in this case.

Cardiovascular system function on hemodynamic maintenance is a resultant of both cardiac and vessels integration.¹⁷ Great deal of effort was put on working towards determining certain predictive vessel diameter cut-off value in relation to risk prognostication and optimal management of relevant diseases.¹⁸⁻²⁰ We propose the application of indices that would better reflect cardiovascular system dimensions as a whole rather than separately.

CONCLUSION

Incidental finding of aortic enlargement should not be disregarded as it might contribute to pathological processes. The use of indices could give a more comprehensive appraisal of cardiovascular system dimensions.

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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AUTHORS CONTRIBUTIONS

Conceptualization: MLEP. Data acquisition: MLEP, DM, DS and MW. Data analysis or interpretation: all authors. Drafting of the manuscript: MLEP, DM, HGW. Critical revision of the manuscript: DM, DS, MW, AP, HGW. Approval of the final version of the manuscript: all authors.

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