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Assessment of the Diameter of Thoracic Aorta by Computed Tomography of Chest

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ABSTRACT

Introduction: The aim of this study was to assess the diameters of thoracic aorta of normal Nepalese people by using computed tomography scans of chest and to correlate the diameters with the patient's age, gender, height, weight and BMI.

Methods: This prospective study was performed in the Department of Radiology and Imaging, TUTH. Data were collected over the period of 4 months from June to September 2017 with the total of 99 patients who underwent contrast enhanced CT of chest in the tertiary hospital.

Results: The diameter of thoracic aorta was found to be maximum at the level of aortic valve sinus (3.23± 0.36 cms), minimum at the level of diaphragm (2.20 ± 0.31 cms), and mean diameter of ascending aorta was found to be 2.73 ± 0.27 cm.

Conclusion: This study concluded that the diameter of thoracic aorta increased with increase in age and vice versa. The diameter of thoracic aorta decreased in the tapering fashion distally from the aortic valve sinus.

Key Words: *Aortic diameter; Ascending thoracic aorta; Descending thoracic aorta*

INTRODUCTION

The aorta is the main artery in the human body that distributes oxygenated blood to all part of the body through the systemic circulation. It extends from the heart to about the fourth lumbar vertebra and is divided into thoracic and abdominal sections. The thoracic section is further divided into four segments: aortic bulb (root), ascending aorta, aortic arch and descending aorta.

CT angiography uses an injection of iodine-rich contrast media and CT scanning to help diagnose and evaluate vascular disease or related condition such as aneurysm or

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blockage. Aortography is performed by x-ray with catheters, MRI, and CT which is usually the most useful technique in imagining of aorta and produce detailed image of vessels.

The specific objectives are to measure the diameter of ascending and descending thoracic aorta and to correlate with the patient's age, gender, height, weight and BMI.

METHODS

This cross sectional study was conducted in a tertiary hospital of Kathmandu on all the patients referred for contrast enhanced CT chest in Department of Radiology from June 2017 to September 2017. Axial images were obtained using Siemens Somatom Definition AS +, 128 slice CT scanner. CT scans were obtained with the patient in supine position during full inspiration. The scan range was from 2 cm above lung apices to the diaphragm. The exposure parameters were 120 kVp, 50-300 mA and a slice thickness of 5mm.

The diameters of the aorta were measured at the levels of aortic valve sinus, ascending aorta, proximal to innominate artery, transverse aortic arch, distal transverse aortic arch, aortic isthmus and descending aorta at the level of diaphragm perpendicular to the axis of the blood flow in the aorta in the operator console of the CT scanner.

Inclusion criteria were all patients referred for the contrast enhanced CT chest in the Department of Radiology and patients who were diagnosed with normal mediastinum and without history of cardiovascular diseases.

Exclusion criteria were patients having pathological changes such as pulmonary embolism, aortic aneurysm, aortic atherosclerosis, aortic regurgitation, aortic dissection, aortic stenosis and aortitis ; non-Nepalese patients and uncooperative patients.

Statistical analyses were carried out with the help of SPSS version 20 and Microsoft Excel. The mean, standard deviation, and correlation between diameters of thoracic aorta at all the levels with the age group, gender, weight group, height group, and BMI group were expressed in tables, figures and the scatter plot diagrams.

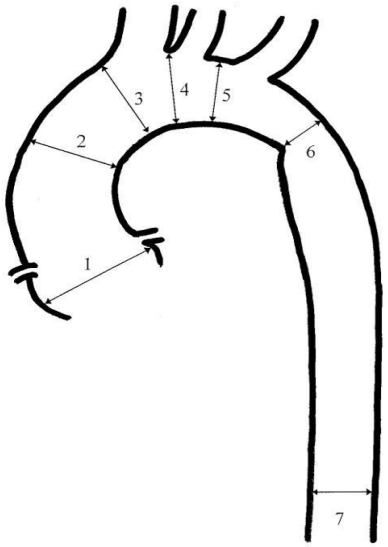

Figure 1: *Levels of measurement aortic diameters: 1, Aortic valve sinus; 2, ascending aorta; 3, aorta proximal to innominate artery; 4, proximal transverse aortic arch; 5, distal transverse aortic arch; 6, aortic isthmus; 7, descending aorta at the level of diaphragm.*

Multiple planar reconstructions were generated on a view workstation (Siemens Medical Systems). The slices were manually adjusted for each aortic level to get an oblique plane strictly perpendicular to the course of the aorta. The internal diameter of the vessel was measured with an electronic caliper. All images were reconstructed and analyzed.

The data were collected in Microsoft Excel and were analyzed using SPSS program version 20. Normal distribution of the diameter was assumed. To analyze the changes of the diameters along the course of the aorta, paired samples test of neighboring diameters were used. Study was approved by institutional review board.

RESULTS

The data was collected from 99 normal subjects, 52 males and 47 females with age from 21 years old up to >70 years old.

***Table 1*: Distribution of sample size according to gender**

Gender	Frequency	Percent
Male	52	52.5%
Female	47	47.5%
Total	99	100%

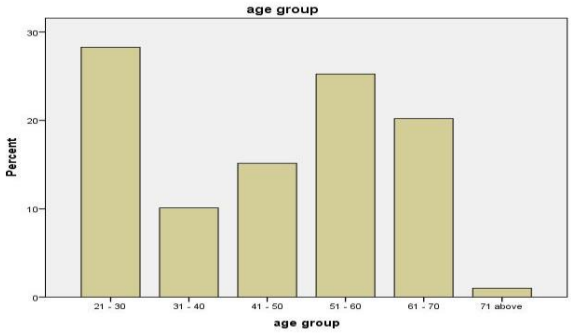

Figure 2: *Bar chart of distribution of sample size according to age group*

***Table 2*: Mean and standard deviation of the age, height, weight, BMI, and diameters of aorta at the level of aortic valve sinus, ascending aorta, proximal to innominate artery, proximal transverse arch, distal transverse arch, isthmus, mean DOAA and DODA**

Variables	Mean	Std. Deviation
Age	46.05	15.121
Height	31.2121	5.66456
Weight	57.3939	8.15014
BMI	24.8005	4.19093
aortic valve sinus	3.2300	.36466
ascending aorta	2.8833	.38750
proximal to innominate artery	2.8702	.35361
proximal transverse arch	2.6297	.33562
distal transverse arch	2.4768	.28630
Isthmus	2.3145	.29843
mean DOAA	2.7348	.27193
DODA	2.2022	.31265

Table 3: Correlation and P value of Mean DOAA and Age group, Weight group, Height group, BMI group

Mean DOAA	Age group		Weight group		Height group		BMI group	
	Pearson correlation	P value	Pearson correlation	P value	Pearson correlation	P value	Pearson correlation	P value
	.394 **	.000	.029	.779	.108	.288	-.117	.250

** Correlation is significant at 0.01 level (P value)

At 0.01 level of significance, there was a significant correlation of mean DOAA with only the age of the individuals (Table 3). There was a significant correlation of DODA with only the age of the individual (Table 4).

There was no significant correlation of mean DOAA and DODA with the weight, height, and BMI of the individual at 0.01 level of the significance.

Table 4: Correlation and P value of DODA and Age group, Weight group, Height group, BMI group

DODA	Age group		Weight group		Height group		BMI group	
	Pearson correlation	P value	Pearson correlation	P value	Pearson correlation	P value	Pearson correlation	P value
	.317**	.001	-.054	.596	.107	.290	-.185	.067

** Correlation is significant at 0.01 level (P value)

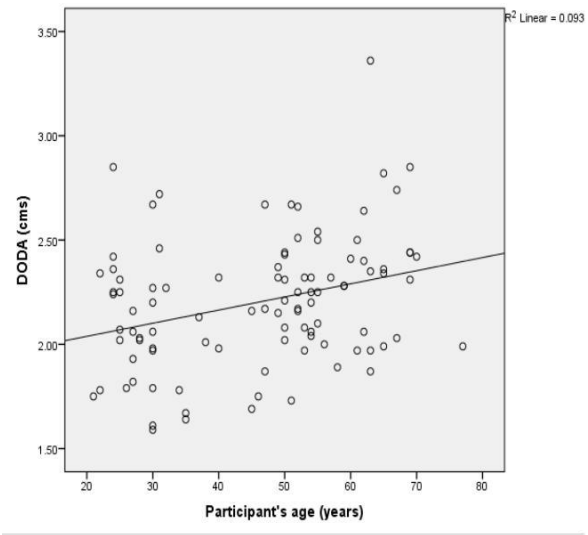

***Figure 3**: Scatter plot diagram of DODA (cm) and Age (years)*

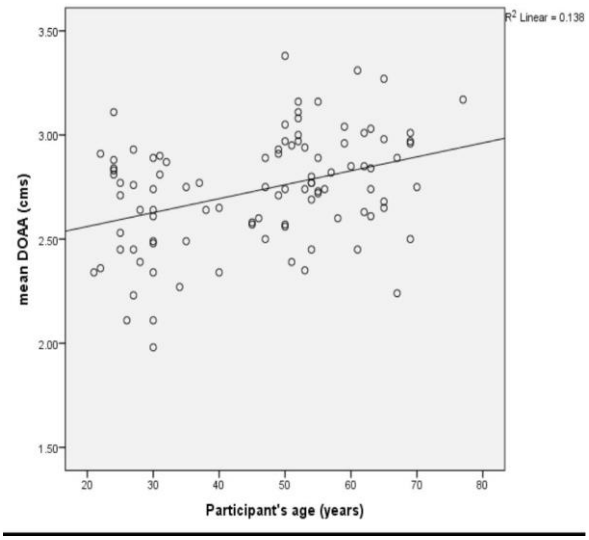

***Figure 4**: Scatter plot diagram of mean DOAA (cm) and Age (years)*

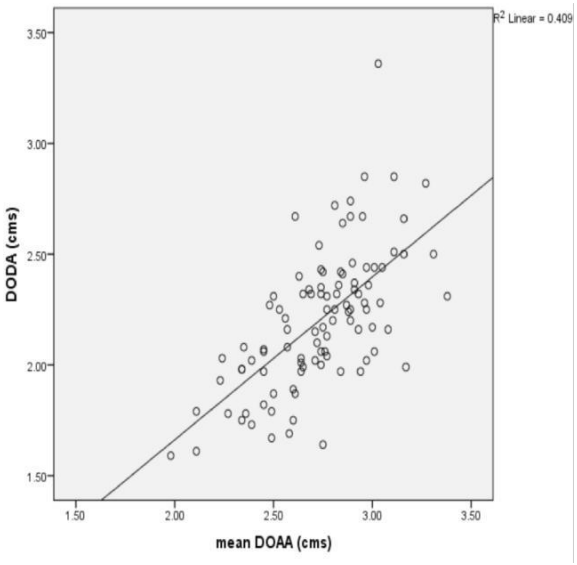

***Figure 5**: Scatter plot diagram of DODA (cm) and mean DOAA (cm)*

The diameter of thoracic aorta at other levels were found simultaneously, 2.88 $\pm$ 0.39 cms at the level of ascending aorta, 2.87 $\pm$ 0.35 cms at the level proximal to innominate artery, 2.63 + 0.34 cms at the level of proximal transverse aortic arch, 2.48 $\pm$ 0.29 cms at the level of distal transverse aortic arch, and 2.31 $\pm$ 0.30 cms at the level of aortic isthmus.

From the paired samples test, the sig (p value) between the pairs of adjacent diameters of aorta at different levels were less than 0.05, except in a pair of diameters at ascending aorta and proximal to innominate artery with the p value 0.715. Hence there was a statistically significant difference between the diameters of aorta at all the adjacent pairs except the pair of diameters at ascending aorta and proximal to innominate artery. (Table 6)

Table 6: Paired samples test between the diameters of thoracic aorta at adjacent levels

Paired Samples Test									
		Paired Differences					T	df	P value
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
	aortic valve sinus - ascending aorta	.34667	.31312	.03147	.28422	.40912	11.016	98	.000
Pair 1	ascending aorta - proximal to innominate artery	.01313	.35742	.03592	-.05816	.08442	.366	98	.715
Pair 2	proximal to innominate artery - proximal transverse arch	.24051	.22822	.02294	.19499	.28602	10.486	98	.000
Pair 3	proximal transverse arch - distal transverse arch	.15293	.20997	.02110	.11105	.19481	7.247	98	.000
Pair 4	distal transverse arch - isthmus	.16222	.21551	.02166	.11924	.20520	7.490	98	.000
Pair 5	isthmus – DODA	.11232	.32189	.03235	.04812	.17652	3.472	98	.001
Pair 6									

P value>0.05- no statistical significance between two variables P value<0.05- statistical significance between two variables

DISCUSSION

The objectives of this study were to assess diameter of the thoracic aorta at different levels of adult Nepalese people by using CT and to correlate the DOAA and DODA with the patient's age, gender and body mass index. At 0.01 level of significance, there was a significant correlation of mean DOAA and DODA with only the age of the individuals. There was no significant correlation with the weight, height, and BMI.

The study done by Hager et al. resulted that all diameters increased with age. There was no influence of weight, height, or body surface area.[1] Musa also concluded that the diameters of thoracic aorta at different levels had significant relation with the age of the individual.[2]

Mao et al. concluded the diameter of ascending aorta had a significant linear correlation with gender.[3] Lin et al. found that the aortic root and ascending aortic diameter increased significantly with age.[4]

Davis et al. concluded the presence of significant linear correlation of gender with the diameter of ascending aorta.[5] The diameter at each level was found to increase with respect to age supported the study done by Gracier.[6]

There was a significant increase of DODA and mean DOAA with age of the participant.

The scatter plot diagrams presenting the relation of DODA and mean DOAA with age of the patient are represented in scattered plot diagrams (Fig 3, 4). The scatter plot diagrams showed the high positive correlation between age and diameter, low positive correlation between height and diameter, high negative correlation between BMI and diameter, and low negative correlation between weight and diameter of the aorta. There was a high positive correlation between DODA and mean DOAA (Fig 5).

Despite the adequate sample size, it was still small for generalization of the study. We measured patient's parameter manually and the value may not be consistent. In addition, the measured diameters may not be considered true as the patients were referred having certain clinical condition which warrants the need of the chest CT scan. We measured the diameter of the aorta of different patients so the level of the site of measurement might not be the same in all cases. The sample size is not adequate to generalize the result and required the measurement with large sample size.

Measurement of the aortic diameter should be taken at reproducible anatomic landmarks, perpendicular to the axis of the blood flow if measurements are taken by the CT, MRI or echocardiography. Abnormal morphology should be recognized when aortic diameter within normal limits. Further descriptive analytic studies are needed using other imaging modalities as MRI or echocardiography to confirm these results that represented in index so as to help in diagnosis of aortic problem which lead to enlargement or decreasing in its size.

CONCLUSION

The diameter of thoracic aorta was found to be maximum at the level of the aortic valve sinus (3.23± 0.36 cms), minimum at the level of diaphragm (2.20 + 0.31 cms), and mean diameter of ascending aorta was found to be 2.73 + 0.27 cms.

The measurement of diameter of thoracic aorta at each level had significant correlation with age but not with gender, height, weight and BMI. The diameter of thoracic aorta decreased in the tapering fashion distally from the aortic valve sinus.

CONFLICT OF INTEREST

None

SOURCES OF FUNDING

None

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