Orginal Article

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

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Abstract

Introduction: Computed tomography (CT) is frequently used for the evaluation of different aortic diseases which is a good method of measuring the aortic diameter. Thus, knowledge of normal aortic diameters is very important in the assessment of aortic disease.

Methods: This was a prospective cross sectional study done on 105 patients who presented in department of Radiodiagnosis in Lumbini Medical College, Palpa, Nepal from February 5th 2022 to February 4th 2023. Plain helical scan was performed using Siemens Somatom 16 slice CT scanner. CT images were obtained in supine position with full inspiration. Diameters of the aorta was measured at the level 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 aorta.

Results: Diameter of thoracic aorta was found to be maximum at ascending aorta with mean of 2.85 cm, followed by aortic valve sinus 2.80 cm, 2.68 cm at proximal to innominate artery, 2.57 cm at proximal transverse arch, 2.41 cm at distal transverse arch, 2.24 cm at isthmus and 2.03 cm at descending aorta at the level of diaphragm. There was smooth tapering of aortic diameter from ascending aorta onwards. There was a significant correlation of mean ascending aorta diameter with the age of the patients($r = 0.475$, $p < 0.05$).

Conclusion: Diameter of thoracic aorta was found to be maximum at the level of the ascending aorta and minimum at the level of diaphragm. The diameter of thoracic aorta had significant correlation with the age of patients.

Keywords: *Aortic diameter, computed tomography, thoracic aorta*

Introduction

Computed tomography (CT) is frequently used for the evaluation of different aortic diseases which is a good method of measuring the aortic diameter. Aorta is the main vessel in the human body, which arises from left ventricle and distributes oxygenated blood throughout the body. Its size is equivalent to an individual's height and weight.[1] It originates from heart at aortic root extending inferiorly where it bifurcates into common iliac arteries anterior to fourth lumbar vertebra. It is mainly divided into thoracic and abdominal aorta. Thoracic aorta is further divided into aortic root, ascending aorta, aortic arch and descending aorta.[2] Aorta undergoes changes due to aging with some reports suggesting gender related changes to its diameter.[3] Various imaging modalities are used to delineate diameter of aorta like chest X-ray, echocardiography, computer tomography (CT) and magnetic resonance imaging (MRI). CT has proved to be informative

and non-invasive examination technique in diagnosis of various aortic diseases.[4] Because of large lumen of aorta diameter and its longitudinal direction perpendicular to the transverse imaging plane CT has become an important imaging technique.[5] Thus, knowledge of normal aortic diameters is very important in the assessment of aortic disease.

The aim of this study is to assess the diameter of thoracic aorta by computed tomography and to see its correlation with the patient's age, height, weight and body mass index.

Methods

This was a prospective cross sectional study conducted in the Department of Radiodiagnosis at Lumbini Medical College and Teaching Hospital over a period of one year from from February 5th 2022 to February 4th 2023. The ethical approval was taken prior to study from institutional review committee of Lumbini Medial College. Written informed consent was obtained from all participants of the study.

Total of 105 patients meeting the inclusion criteria were included in the study. Plain helical scan was performed using Siemens Somatom 16 slice CT scanner. CT images were obtained in supine position with full inspiration. Entire thorax was obtained from lung apices to the diaphragm. The exposure parameters were 120 kVp, 50- 300 mA and slice thickness of 5mm. Contrast was given after an antecubital intravenous injection of 50 to 60 mL of a non-ionic contrast medium containing 300 mg/mL of iodine mostly on right arm. Injection rate was 1.5 to 3mL/s. Height and weight of the patients were measured after which BMI was calculated. Diameters of the aorta was 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 aorta. 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.

Patients' data were collected and analyzed using Statistical package for social sciences (SPSS) program version 20. Analysis was done using descriptive statistics like frequency, percentage, mean and standard deviatation. Normal distribution of the diameter was assumed. Correlation(r) of ascending aorta was analyzed with Age, Weight, Height and BMI group. A P value < 0.05 was considered as statistically significant.

Inclusion criteria:

- Patients referred for contrast enhanced CT chest in Department of Radiology without evident cardiovascular disease.

Exclusion criteria:

- Overt aortic atherosclerosis
- Pulmonary embolism
- Aortic aneurysm
- Aortic dissection
- Aortic stenosis
- Aortitis

Results

A total of 105 patients were enrolled for the study. The minimum age was 26 years old and maximum age was 86 years old with mean age of 58 ± 13.93 years old. 54 (51.4%) patients were female and 51 (48.6%) patients were male. Minimum height of the patient was 124 cm and maximum height was 179 cm with mean height of 155.41cm ± 12.26. Similarly, minimum weight of the patient was 30 kg and maximum weight was 79 kg with mean weight of 55.10 kg ± 11.09. BMI was categorized as underweight as value of <18.5 and overweight as ≥ 25 with normal weight as 18.6-24.9. Minimum BMI was 13.10 and maximum was 34.60 with mean BMI of 22.60 ±3.54 (Table 1).

Diameter of thoracic aorta was found to be maximum at ascending aorta with mean of 2.85 cm, followed by aortic valve sinus 2.80 cm, 2.68 cm at proximal to innominate artery, 2.57 cm at proximal transverse arch, 2.41 cm at distal transverse arch, 2.24 cm at isthmus and 2.03 cm at descending aorta at the level of diaphragm. There was smooth tapering of aortic diameter from ascending aorta onwards (Table 2). There was a significant correlation of mean ascending aorta diameter with the age of the patients(r 0.475, p< 0.05) (Table 3).

Table. 1: Demographic data of patients

	Male	Female	Total(Mean± SD	Minimum	Maximum
Age(Years)	56.16±14.40	59.74±13.38	58 ± 13.93	26	86
Weight(Kg)	61.29±10.36	49.25±8.27	55.10±11.09	30	79
Height(cm)	162.71±6.06	148.52±12.68	155.41 cm ± 12.26	124	179
Body mass index	22.80±3.24	22.42±3.75	22.60±3.54	13.10	36.40

Table 2: Aortic diameters at various thoracic levels

	Male	Female	Total (Mean ± SD	Minimum	Maximum
Aortic valve sinus(cm)	2.81± 0.31	2.80±0.31	2.80±0.31	1.98	3.61
Ascending aorta(cm)	2.85±0.39	2.86±0.38	2.85±0.38	2.05	4.12
Proximal to innominate artery(cm)	2.64±0.35	2.72±0.30	2.68 ±.33	1.97	3.42
Proximal transverse arch(cm)	2.53±0.34	2.62±0.36	2.57 ± .35	1.82	3.76
Distal transverse arch(cm)	2.42±0.31	2.41±0.28	2.41 ± .29	1.60	3.13
Isthmus(cm)	2.25±0.30	2.24±0.25	2.24cm ± .27	1.57	2.95
DODA(cm)	2.08±0.28	1.98±0.22	2.03cm ± .26	1.39	2.87

Table 3: Correlation of ascending aorta with Age, Weight, Height and BMI group

Ascending aorta	Age		Weight		Height		BMI group	
	Pearson correlation	P value	Pearson c orrelation	P value	Pearson correlation	P value	Pearson correlation	P value
	0.475	<0.05	0.07	0.443	-0.018	0.854	0.096	0.330

Discussion

With the introduction of CT since 1980s there have been significant improvement in the assessment of aortic pathology and it has become routine investigation for its evaluation as such. The objectives of the study were to assess the diameter of thoracic aorta by using contrast CT and to correlate with patient's age, weight, height and body mass index.

According to our study there was a significant positive correlation between mean age and mean ascending aortic diameter. This is in line with study done by Martin C et al.[6] According to O'Rourke and Hashimoto[7] arteries demonstrate two main changes with age, which is dilatation and stiffening due to fracture of elastic lamellae. Diameter of thoracic aorta has been shown to increase at different level progressively with age from aortic valve sinus to descending aorta. However, in our study it was found that diameter of ascending aorta to be increased and distal to it there was smooth tapering which is in line to study done by Hager et al.[8] This is in contrast to other studies done by Chang HW et al[9] and Fay Y Lin et al.[10]

In our study dilatation of ascending aorta was seen more in female than male with sex having weak influence with mean values for women and men differing no more than at some levels which is minimal compared to normal variation. This is in contrast to other studies done by Davis A et al[11] and M C Carrero.[12] It could be due to over representation of men in other studies and differences in body size. There was no significant correlation with diameter of aorta with weight, height and BMI.

Different methods are used for imaging of aorta such as echocardiography, chest X-ray, angiography, CT and MRI. Comparing data from these are difficult because some of these focus only on specific segment of aorta. However CT is preferred imaging of choice due to short imaging time, availability, high temporal and spatial resolutions and multiplanar imaging reconstruction. Electrocardiographic (ECG) gating is used to avoid motion artifacts.[13] Modality in which measurements are taken matters because of the obliquity of aorta. Axial measurements are inherently incorrect unless aorta is measured perfectly aligned in cross- section on the image.[14] Sagittal oblique images are helpful for aortic arch evaluation and coronal images are useful for evaluation of aortic root.[15]

Conclusion

Diameter of thoracic aorta was found to be maximum at the level of the ascending aorta and minimum at the level of diaphragm. The measurement of diameter of thoracic aorta had significant correlation with age but not with gender, height, weight and BMI group.

Limitation

Non- gated axial chest CT was used to evaluate thoracic aortic size which does not take account for the obliquity of the lumen or systolic expansion during cardiac cycle. Partial volume averaging effect.

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