

Mean pulmonary artery diameter in chest CT scan in the Thai population



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ABSTRACT

Introduction: Pulmonary hypertension has been associated with a significant increase in morbidity and mortality. The pulmonary artery diameter measurement from a CT scan is routinely used to predict possible evidence of pulmonary hypertension. However, no data available as a reference for the normal range, especially in the Thai Population. The primary purpose of this study was to determine the normal diameter of the main pulmonary artery (MPA) and ascending aorta (AAo) and the ratio between MPA and AAo diameter in the Thai population.

Methods: Patients who met the inclusion criteria and had a chest CT performed in Songklanagarind hospital between 1 January 2014 and 14 July 2014 were enrolled. Measurement of the MPA diameter at the level of its bifurcation and the AAo from an axial-view contrast-enhanced CT chest (venous phase) image was done. The ratio between the diameter of MPA and AAo was then calculated.

Results: 2395 patients were included in this study (male = 1271 patients, female = 1124 patients, aged between 20-96 years; mean = 57 years old). The mean diameter of the MPA was 25.21 mm, and the mean diameter of the AAo was 30.78 mm. The mean MPA/ AAo ratio was 0.83. The sex-specific mean diameters of the MPA were 25.4 mm in men and 25.0 mm in women. The mean diameters of the AAo in men and women were 31 mm and 30 mm, respectively.

Conclusion: The mean MPA diameter obtained from chest CT scans in this study was about 25.4 mm in men and 25.0 mm in women. These values are easily obtained from chest CT scans and are highly reproducible. Therefore, it may be used as a reference value for a healthy Thai population.

Keywords: Pulmonary artery, diameter, Thai population.

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INTRODUCTION

Pulmonary hypertension has been associated with a significant increase in morbidity and mortality.¹ It is involved in many clinical conditions and can complicate many cardiovascular and respiratory diseases.²

Pulmonary hypertension is caused by several diseases, including long-standing cardiac left-to-right shunts due to congenital anomalies, chronic thromboembolic pulmonary diseases, tumour emboli, parasitic emboli, talc crystals and other foreign material deposits, human immunodeficiency virus (HIV), liver diseases, pulmonary vasculitis, chronic alveolar hypoxia due to chronic obstructive pulmonary disease, and chronic interstitial lung

disease.³ Many factors may affect the main pulmonary artery diameter such as sex, age, and underlying disease.^{3,4} An enlarged main pulmonary artery (MPA) is strongly related to pulmonary hypertension as a result of adaptation to the increased pulmonary pressure and vascular resistance.^{1,5}

The gold standard for diagnosing pulmonary hypertension is catheterization of the right side of the heart, but it is an invasive procedure and carries risks of morbidity and mortality. Other diagnostic methods include electrocardiography, chest radiography, pulmonary function tests and arterial blood gas, echocardiography, ventilation/perfusion lung scans, high-resolution computed tomography(HRCT)/contrast-enhanced computed tomography (CT), pulmonary

angiography, cardiac magnetic resonance imaging (MRI), blood and immunology tests, abdominal ultrasonography, and genetic testing.^{6,7,8,9,10,11} Several studies have shown that CT is an effective non-invasive method of predicting the presence of pulmonary hypertension by evaluating the relationship between pulmonary artery diameter and pulmonary hypertension.^{1,4,12}

The pulmonary artery diameter measurement from a CT scan is routinely used to predict possible evidence of pulmonary hypertension.^{1,5,12} However, to date, no study has been performed to determine the normal range of the MPA diameter in the Thai population. This study aimed to determine the normal diameter of the MPA, AAo, as well as the ratio between the diameter of the MPA

and the ascending aorta (AAo) in the Thai population.

METHODS

This retrospective study was conducted at Songklanagarind Hospital, Thailand. The participants included patients who underwent a chest CT at Songklanagarind Hospital between 1 January 2014 and 14 July 2014. A total of 2395 Thai patients older than 20 years of age were enrolled in the study. Patients were excluded if there was (1) any underlying disease that may affect pulmonary artery pressure, e.g., hypertension, chronic obstructive pulmonary disease, pulmonary thromboembolism, left-sided heart disease, mitral valve disease, HIV, hyperthyroidism or autoimmune diseases; (2) any underlying disease that may affect the aorta diameter, such as hypertension, aortic injury and aortic aneurysm; and (3) any newly-found pulmonary thromboembolism and/or pulmonary artery injury. This study was approved by the Commission on Research Ethics, Faculty of Medicine, Prince of Songkla University, number

$$n = \frac{z_{1-\frac{\alpha}{2}}^2 \sigma^2}{d^2}$$

SD (σ) = 0.95, Error (d) = 0.05,
Alpha (α) = 0.01, Z (0.995) = 2.575829
Sample size (n) = 2395

REC.59-002-07-4. The total sample required to achieve the desired level of accuracy was determined by the following calculation.¹³

Image acquisition was performed using a Philips Brilliance™ 64-slice MDCT scanner with the V 2.6.0.22032 software, using 120 kVp and automatic current modulation technique. Non-ionic contrast media at a dose of 1.5-2 ml/kg and an injection rate of 1.5-2.0 ml/sec was used. The venous-phase images were acquired 60 seconds after contrast media administration. Image slice thickness was 3 mm, with a 2-mm thickness interval, and reconstructions into sagittal and coronal views also had a slice thickness of 3 mm and a 2-mm thickness interval. The images were adjusted to the mediastinal window (window level, 40; window width,

Table I. Indications for chest CT

Indications	Numbers
Malignancy	1942
Lymphoma	170
Leukemia	15
Trauma	88
Infection	105
Other	75
Total	2395

Table II. Sex-specific values for the means of MPA diameter, AAo diameter, and MPA/AAo

Sex	MPA (mm)	SD	AAo (mm)	SD	Ratio MPA/AAo	SD
Male	25.40	2.95	31.68	3.78	0.82	0.1
Female	25.00	3.15	29.80	3.76	0.85	0.1

MPA = Main pulmonary artery diameter, AAo = Ascending aorta diameter

400) prior to evaluation.

The patient information collected included sex, age, and the date when the CT scan was performed. The CT scans were evaluated independently by a third-year radiology resident and a radiologist with nine years of experience. A slice of the axial image of the venous-phase chest CT scan (Figure 1) was selected at the MPA bifurcation level. Each patients' MPA and AAo widest diameter (outer-wall to outer-wall) was measured from this image three times, and a mean of the three measurements was used. The MPA and AAo diameters were then used to calculate the MPA/AAo ratio. Finally, descriptive statistics were expressed as the diameter of MPA and AAo for the overall population and each subgroup according to age and sex. The standard deviations of the MPA diameter, AAo diameter, and the MPA/AAo ratio were also calculated.

RESULTS

In total, 2395 patients (male = 1271, female = 1124) between 20 and 96 years of age (mean age = 57 years) were included in this study. The indications for chest CT are shown in Table I. The mean MPA diameter was 25.21 mm, and the mean MPA/AAo ratio was 0.83. The sex-specific mean of the MPA diameter was 25.4 mm in men and 25.0 mm in women (Table II).

The MPA diameter increased with age in both men and women. Among men aged 20-49 years, the MPA's mean



Figure 1. Measurement of the main pulmonary artery and ascending aorta diameters on a transaxial image.

diameters were 24.3-25.09 mm, 25.24-25.59 mm in men aged 50-69 years, and 25.24-25.59 mm in men aged 70-99 years. In women aged 20-49 years, 50-69 years, and 70-99 years, the mean MPA diameters were 23.62-24.35 mm, 24.74-25.42 mm, and 25.98-30.69 mm, respectively (Figure 2 and Figure 3).

The mean of the AAo diameter in men and women were 31 mm and 30 mm, respectively, and the mean of the AAo diameter also increased with age in both sexes. Among males aged between 20-49 years old, the mean AAo diameter was 26.35-29.75 mm; in the 50-69 years age group, the mean diameter was 31.3-32.97 mm; and for the 70-99 years age group, it was 33.69-35.32 mm. Females aged between 20-49 years had a mean AAo diameter of 24.81-28.06 mm; for those in

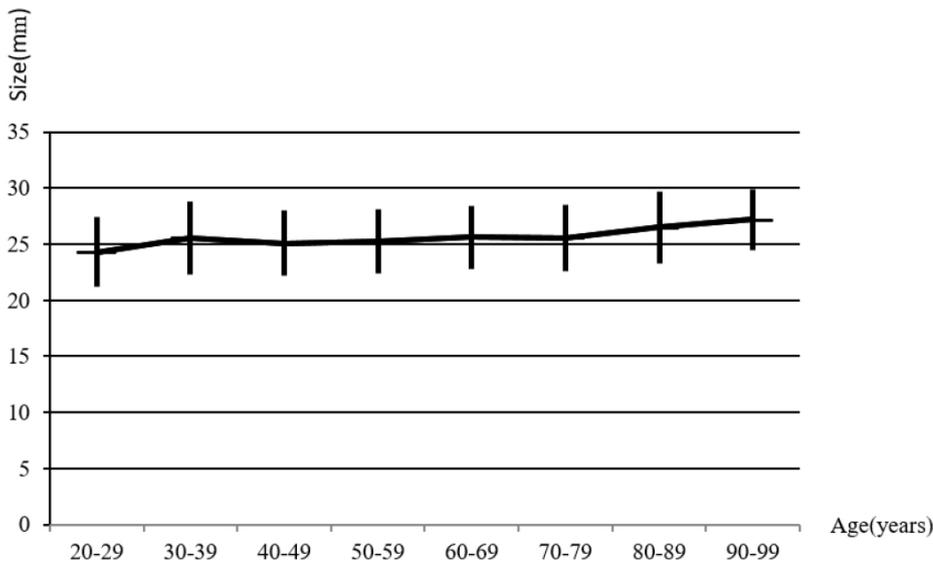


Figure 2. Plotting graph between age and mean diameter of the MPA in Male

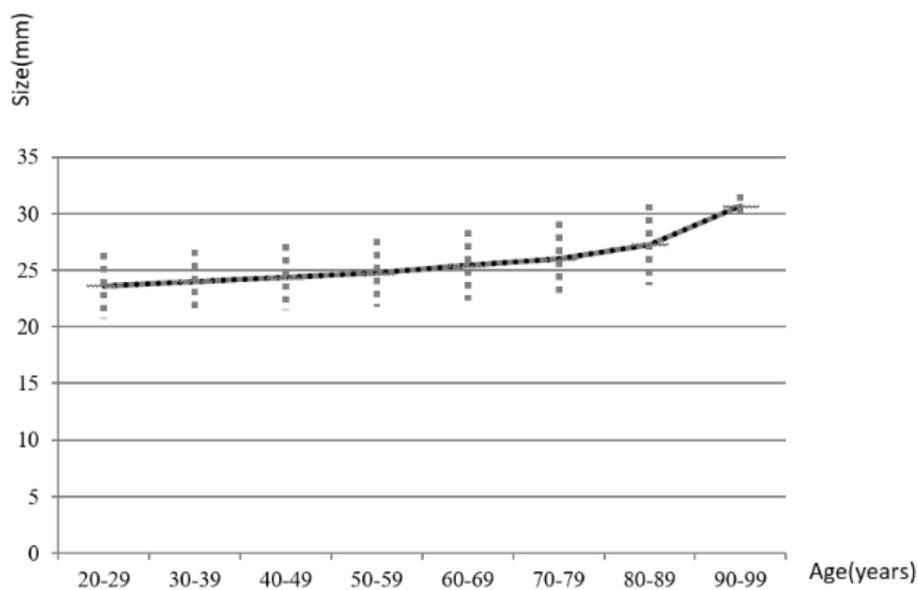


Figure 3. Plotting graph between age and mean diameter of the MPA in female

the 50-69 age group, the mean diameter was 29.76-31.3 mm; and for those aged 70-99 years, the values ranged between 31.8-32.7 mm. The MPA/AAo diameter ratio was 0.8 in men and 0.9 in women. The values of mean MPA diameter, AAo diameter, and MPA/ AAo ratio for each age group and sex are shown in [Table III](#).

DISCUSSION

This study's mean of the MPA diameter was 25.40 mm in males and 25.0 mm in females. Our study found that the MPA diameter values in our population

were smaller than those in other studies. Karazincir et al.⁴ reported an MPA diameter of 27 mm in men and 25.9 mm in women using venous phase CT scans, and Truong et al.⁵, who used non-contrast chest CTs, found MPA diameter values of 29 mm in men and 27 mm in women. This could be due to differences in ethnicity (Asian vs. American population). Like other studies, our male population had a slightly larger MPA diameter than females (25.40 mm vs. 25.00 mm), as well as a larger mean AAo diameter (31 mm vs. 30 mm).

The ratio between MPA and AAo diameters in this study was about 0.8 in men and 0.9 in women—a finding similar to those from other studies that reported ratios below 1.0 in the normal population. This indicates that, in a normal population, the MPA diameter is not larger than that of the AAo at the same level.

Based on the current literature, the relationship between age and MPA diameter is still controversial.^{5,14} Some investigators have found a correlation between age and pulmonary artery diameter, but others have not. In our study, we found a relationship between pulmonary artery diameter and age.

In concurrence with previous investigations, this study also found that as the age increases, so do the MPA and AAo diameters in males and females. However, the MPA to AAo ratio showed a slight decrease with increasing age. This could be explained by the fact that in the elderly population, the AAo shows a greater progressive enlargement compared to the MPA.

This study suffered from the following limitations; first, no actual pulmonary arterial pressure measurement was acquired. Second, although we excluded cases with underlying conditions that may affect the mean pulmonary artery diameter if the patients were not aware of such underlying diseases, they may have been erroneously included in the study.

CONCLUSION

In conclusion, in our population, the mean MPA diameter was about 25.40 mm (22.5-28.5 mm) in males, 25.00 mm (22.0-28.5 mm) in females, and the ratios between MPA and AAo diameters were about 0.8 in males and 0.9 in females. Consequently, if the pulmonary artery diameter is greater than 28.5 mm in males and 28.5 mm in females, pulmonary artery hypertension may be suspected. We propose that our findings be used as reference values for a healthy Thai population.

AUTHOR CONTRIBUTION

All authors have contributed to all processes in this research, including preparation, data gathering, analysis, drafting, and approval to publish this manuscript.

Table III. Relationship between age group, sex, and MPA, AAO diameter, and MPA/ AAO ratio.

Male (1271)							
Age (years)	Number	Mean MPA (mm)	SD	Mean AAO (mm)	SD	Mean Ratio MPA/ AAO	SD
20-29	62	24.3	3.08	26.35	2.50	0.92	0.09
30-39	67	25.54	3.22	28.15	2.66	0.91	0.09
40-49	168	25.09	2.94	29.75	3.18	0.85	0.08
50-59	346	25.24	2.89	31.30	3.37	0.81	0.09
60-69	341	25.59	2.81	32.97	3.26	0.78	0.09
70-79	232	25.56	2.97	33.69	3.38	0.76	0.09
80-89	52	26.49	3.18	33.63	2.68	0.79	0.10
90-99	3	27.18	2.70	35.32	2.69	0.77	0.06
Female (1124)							
20-29	39	23.62	2.95	24.81	2.94	0.96	0.11
30-39	91	24.02	2.79	26.45	2.96	0.91	0.09
40-49	178	24.35	2.91	28.06	3.38	0.87	0.10
50-59	354	24.74	3.01	29.76	3.34	0.84	0.10
60-69	269	25.42	3.10	31.30	3.13	0.81	0.09
70-79	160	25.98	3.33	31.80	3.34	0.82	0.10
80-89	31	27.26	3.60	32.78	3.33	0.83	0.08
90-99	2	30.69	0.97	32.70	2.49	0.94	0.04

MPA = Main pulmonary artery, AAO = Ascending aorta

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CONFLICT OF INTEREST

All authors have no conflict of interest to declare.

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