International Journal of Scientific Reports
Wani AH et al. Int J Sci Rep. 2019 Jun;5(6):145-149
http://www.sci-rep.com
pISSN 2454-2156 | eISSN 2454-2164

DOI: http://dx.doi.org/10.18203/issn.2454-2156.IntJSciRep20192064

Original Research Article

Main pulmonary artery diameter assessment in a large sample of Indian population: a MDCT based study

Abdul Haseeb Wani[1], Yassar Shiekh[2], Najeeb Tallal Ahangar[2]*

Department of Radiodiagnosis, [1]Sher-e-Kashmir Institue of Medical Sciences, [2]Government Medical College, Srinagar, Jammu and Kashmir, India

Received: 12 April 2019
Revised: 24 April 2019
Accepted: 29 April 2019

***Correspondence:**
Dr. Najeeb Tallal Ahangar,
E-mail: tallalnajeeb@gmail.com

ABSTRACT

Background: The gold standard for pulmonary artery pressure measurement is right heart catheterization but its invasive nature precludes its routine use. Main pulmonary arterial trunk calibre increase is a strong indicator of underlying pulmonary arterial hypertension. MDCT can accurately measure the diameter of main pulmonary artery. The objective of the study was to establish the normative values of main pulmonary artery caliber using contrast enhanced CT and try to ascertain any significant difference in main pulmonary artery calibers between two genders and correlation of age and main pulmonary artery diameter.
Methods: Contrast enhanced CT images of 462 subjects were analysed on a PACS workstation monitor and widest diameter perpendicular to long axis of the main pulmonary artery as seen on reformatted axial image was measured with electronic caliper tool at the level of the main pulmonary artery bifurcation.
Results: The mean main pulmonary artery diameter in females was 22.54±2.19 mm and 23.34±3.06 mm in males. The mean pulmonary artery diameter in males was larger than females with statistically significant difference seen ($p<0.05$). The correlation coefficient between age of whole sample and their mean main pulmonary artery was found to be 0.1006 with no statistically significant difference.
Conclusions: There is a statistically significant difference in the mean main pulmonary artery calibre between males and females with no strong correlation between the age and mean main pulmonary artery calibre. Further studies are warranted to find the complex interaction between main pulmonary artery diameter and sex, age and body mass index.

Keywords: Main pulmonary artery, Main pulmonary artery diameter, Contrast-enhanced CT thorax, Electronic caliper tool, Reformatted axial image, Correlation coefficient

INTRODUCTION

Unlike systemic arterial pressure, there is no bedside non-invasive palpatory method available for the measurement of pulmonary artery pressure. The gold standard for pulmonary artery pressure measurement is right heart catheterization but its invasive nature with definite albeit small risk of morbidity and mortality precludes its routine use.[1,2] Increase in the pulmonary artery diameters especially the main pulmonary arterial trunk is a strong indicator of underlying pulmonary arterial hypertension.[3] This makes establishment of normal pulmonary artery diameters a must which can serve as a baseline to objectively measure any increase in the size of pulmonary artery. Many easily measurable non-invasive and indirect surrogate markers have been used by clinicians among which the pulmonary artery diameter appears to be reasonably reliable and reproducible. Measurement of descending right pulmonary artery diameter on routine postero-anterior (PA) chest radiographs resonates well

with few researchers in predicting the normalcy of pulmonary artery pressures.[4-6] However, measuring artery size by chest radiography suffers from significant drawbacks like lack of standard site of measuring the right descending pulmonary artery, superimposition of hilar and mediastinal shadows making its measurement difficult and magnification differences in various X-ray views and positions.[7] Multi-detector computed tomography (MDCT) with its multi-planar reformation capability can accurately measure the diameters of great vessels of thorax. Increase in main pulmonary artery diameter as seen on CT has been shown to be a reliable indicator of pulmonary arterial hypertension by various studies.[6-12] To the best of our knowledge, very few studies have measured and established the normal values of main pulmonary artery diameters on CT along with gender variation.[8-10,13] We undertook this study to establish the normal range of main pulmonary artery diameter in persons with normal pulmonary arterial pressures and to evaluate whether any significant gender difference exists in normal pulmonary diameter ranges.

METHODS

This was a retrospective observational study where we evaluated a total of 462 subjects who had undergone contrast-enhanced computed tomography of thorax between September 2017 to August 2018 in accident/emergency and outpatient CT sections of our hospital (Govt. Medical College, Srinagar) for various indications. Subjects with history of cardiac/ pulmonary pathologies known to cause increase in pulmonary artery pressures (left to right/ right to left cardiac and extra-cardiac shunts, obstructive lung diseases, interstitial lung diseases, heart failure, pulmonary thrombo-embolism etc), those who had received thoracic radiotherapy, those with echocardiography documented elevated pulmonary artery pressures or congenital/ acquired right ventricular outflow tract obstruction were not included in the study. Institutional ethical committee clearance was obtained and informed consent taken from all the subjects included in the study. Contrast-enhanced CT examinations (64 slice Siemens somatom sensation, Germany) were obtained in breath hold while examining thorax for different indications. Non-ionic contrast material (100 to 150 ml as per body weight with iodine concentration of 300 mg/100 ml) was injected via 18-gauge intravenous cannula inserted into cubital vein by a power injector as per our institutional protocol. Contrast CT was taken after automatic bolus triggering in some cases and after a fixed delay (20 or 30 seconds after start of contrast infusion) in some cases. On the CT workstation after retrieval of data from picture archiving and communication system (PACS) multi-planar coronal, sagittal and axial reconstructions were performed. Reconstruction parameters were slice thickness 1.5 mm, recon increment 1.0 mm, field of view (FOV) 380×380 mm, window: mediastinum (window width/centring 400/40) and kernel as B30f medium smooth (Body 30 fast). Analysis of CT images was done on a PACS workstation monitor by an experienced radiologist. The widest diameter perpendicular to the long axis of the main pulmonary artery as seen on reformatted axial image (Figure 1) was measured with electronic caliper tool at the level of the main pulmonary artery bifurcation. The outer limits of the contrast were used to determine the artery diameter.

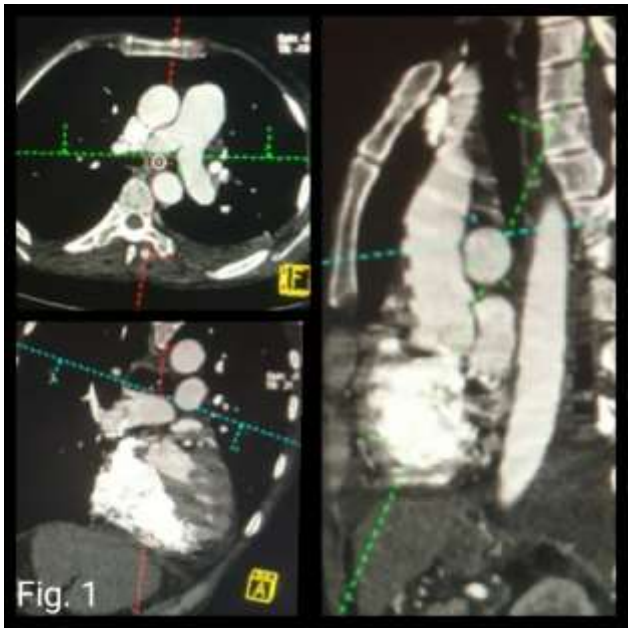

Figure 1: 3D multi-planar reformation of contrast enhanced CT image with reformation lines placed in sagittal and coronal planes in such a way as to obtain the maximum length of main pulmonary artery in reformatted axial plane.

Statistical analysis

The data was analysed using statistical softwares SPSS v 20 and STATA v 11. Categorical variables were described in terms of frequency and range and the continuous variables in terms of descriptive statistics like mean and standard deviation. The p value <0.05 indicated a significant statistical difference using two-sample independent student t test as population distribution was Gaussian in nature. Pearson correlation coefficient (R value) was calculated using an algorithm supplied by Meta Numerics statistical library.

RESULTS

Contrast-enhanced CT thorax of 462 subjects were analysed with equal number of males (n=231) and females (n=231). Mean age of females was 44.51±14.42 years with age range 21–75 years. Mean age of males was 55.03±13.61 with age range of 24–75 years. No statistically significant difference (p=0.3813) was seen in mean age and range of the two gender groups. The mean main pulmonary artery diameter in females was 22.54±2.19 mm. The smallest and largest diameter of main pulmonary artery in females in our study was 18.1 mm and 27.4 mm respectively. The mean main

pulmonary artery diameter in males was 23.34±3.06 mm. The smallest and the largest diameter of main pulmonary artery in our study in males was 18.3 mm and 29.7 mm respectively. The mean pulmonary artery diameter in males was larger than females with statistically significant difference seen (p<0.05). The correlation coefficient (R value) was found to be 0.2513. The correlation coefficient between the age of whole sample and their mean main pulmonary artery was found to be 0.1006 (Figure 2) with no statistically significant difference seen (p=0.4215). Because of this weak correlation coefficient, discriminant analysis was not performed. These findings are summarized in Table 1.

Table 1: Age and main pulmonary artery diameter in males and females in our study (n=231).

S. no	Parameter		Males	Females	P value
1.	Age (years)				
	Mean		55.03	44.51	1.3813
	Standard deviation		13.61	14.42	
	Range	Min.	24	21	
		Max.	75	75	
2.	Main pulmonary artery diameter (mm)				
	Mean		23.34	22. 54	<0.05
	Standard deviation		3.06	2.19	
	Range	Min.	18.3	18.1	
		Max.	29.7	27.4	

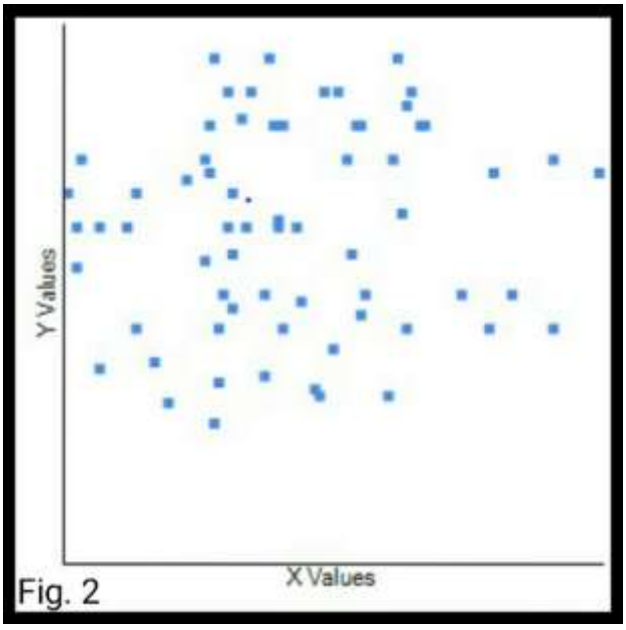

Figure 2: Dot diagram showing relationship between main pulmonary artery diameter (X values) and age (Y values). The widely scattered dots indicating no strong relationship between main pulmonary artery diameter and age.

DISCUSSION

Main pulmonary artery diameters are often used as indirect surrogate markers for the mean pulmonary artery pressures. Contrast-enhanced CT of thorax is a non-invasive way to establish the normative values of main pulmonary artery diameter. Magnitude of factors have been reported to influence the calibre of main pulmonary trunk. Apart from various pathologies affecting lung parenchyma and cardiac morphology, various physiological parameters like gender, age, body-mass index and height may influence the calibre of main pulmonary artery and its branches.[14,15] Mean age of females was 44.51±14.42 years and 55.03±13.61 years in males in our study. No statistically significant difference (p=0.3813) was seen in mean age in the two gender groups. The correlation coefficient between the age of 462 subjects in our study and their mean main pulmonary artery was found to be 0.1006, with no statistically significant difference seen (p=0.4215). The reported relationship between age and main pulmonary artery calibre has been controversial.[8,9,11,16,17] Some investigators report a correlation between age and pulmonary artery diameter while others negate the same. We found no effect of age on the calibre of main pulmonary artery trunk. As ours was a retrospective observational study we could not evaluate the effect of body mass index on the calibre of main pulmonary trunk. The mean main pulmonary artery diameter in females (Figure 3) was 22.54±2.19 mm. The smallest and largest diameter of main pulmonary artery in females in our study was 18.1 mm and 27.4 mm respectively. The mean main pulmonary artery diameter in males (Figure 3) was 23.34±3.06 mm. The smallest and the largest diameter of main pulmonary artery in our study in males was 18.3 mm and 29.7 mm respectively. The range of main pulmonary artery diameter in our study was 18.1 to 29.7 mm with no subject in our study having a calibre in excess of 30 mm similar to various studies.[18,19] The mean diameter of main pulmonary artery in our study was less than the diameters reported by many studies while similar values were reported by Kuriyamaet al.[8,9,13] The mean pulmonary artery diameter in males was larger than females with statistically significant difference seen (p<0.05). We also found that the main pulmonary artery diameter showed a normal distribution in healthy adult subjects having no cardiac/lung pathology. However, without measuring pulmonary artery pressures in all

subjects and excluding the occult PA hypertension patients, normal limits of main pulmonary are difficult to establish with high sensitivity.

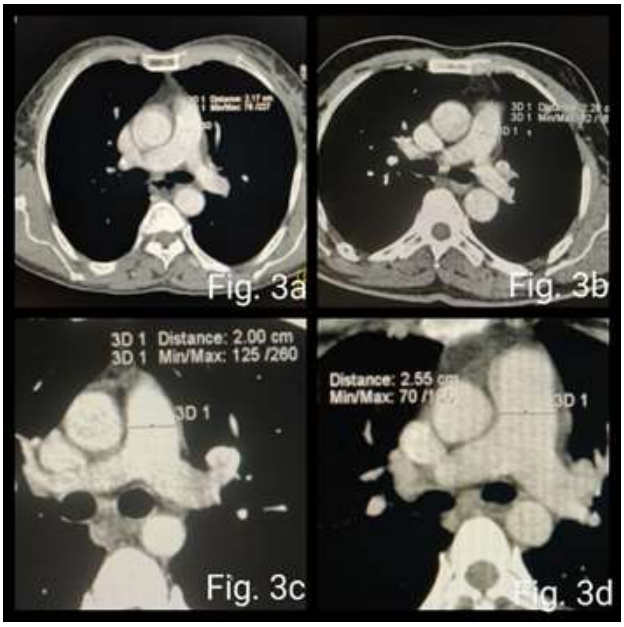

Figure 3: Contrast-enhanced reformatted axial CT images (a, b) and magnified images (c, d) showing the main pulmonary diameters: 21.7 mm (a), 22.8 mm (b), 20.0 mm (c) and 25.5 mm (d) as measured with electronic caliper tool.

In nutshell, we conclude by saying that there is a statistically significant difference in the mean main pulmonary artery calibre between males and females with no strong correlation between the age and mean main pulmonary artery calibre. The range of main pulmonary artery diameter in our study was 18.1 to 29.7 mm with no subject in our study having a calibre in excess of 30 mm or less than 18 mm. Further studies are warranted to find the complex interaction between main pulmonary artery diameter and the sex, age and body mass index. Multiple logistic regression needs to be applied to rule out any confounding influence of these physiological variables on the main pulmonary artery calibre.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. van Erkel AR, van Rossum AB, Bloem JL,Kievit J, Pattynama PM. Spiral CT angiography for suspected pulmonary embolism:cost-effectiveness analysis. Radiology. 1996;201:29–36.
2. Stein PD, Athanasoulis C, Alavi A, Greenspan RH, Hales CA, Saltzman HA, et al. Complications and validity of pulmonary angiography in acute pulmonary embolism. Circulation. 1992;85:462–8.
3. Altman DG, Bland JM. Measurement in medicine:the analysis of method comparison studies. J Royal Statistical Society: Series D (The Statistician). 1983;32(3):307-17.
4. Kanemoto N, Furuya H, Etoh T, SasamotoH, Matsuyama S. Chest roentgenograms in primary pulmonary hypertension. Chest 1979;76:45–49.
5. Matthay RA, Schwarz MI, Ellis JH Jr, Steele PP, Siebert PE, Durrance JR, et al. Pulmonary artery hypertension in chronic obstructive pulmonary disease: determination by chest radiography. Invest Radiol. 1981;16:95–100.
6. Schmidt HC, Kauczor HU, Schild HH, Renner C, Kirchhoff E, Lang P, et al. Pulmonary hypertension in patients with chronic pulmonary tromboembolism: chest radiograph and CT evaluation before and after surgery. Eur Radiol. 1996;6:817– 25.
7. Haimovici JB, Trotman-Dickenson B, Halpern EF, Dec GW, Ginns LC, Shepard JA, et al. Relationship between pulmonary artery diameter at computed tomography and pulmonary artery pressures at right-sided heart catheterization. Massachusetts General Hospital Lung Transplantation Program. Acad Radiol. 1997;4:327–34.
8. Edwards PD, Bull RK, Coulden R. CT measurement of main pulmonary artery diamater. Br J Radiol. 1998;71:1018–20.
9. Kuriyama K, Gamsu G, Stern RG, Cann CE, Herfkens RJ, Brundage BH. CT-determined pulmonary artery diameters in predicting pulmonary hypertension. Invest Radiol. 1984;19:16–22.
10. Tan RT, Kuzo R, Goodman LR, et al.Utility of CT scan evaluation predicting pulmonary hypertension in patients with parenchymal lung disease. Chest. 1998;113:1250–6.
11. Ng CS, Wells AU, Padley SP. A CT sign of chronic pulmonary arterial hypertension:the ratio of main pulmonary artery to aortic diameter. J Thorac Imaging. 1999;14:270–8.
12. Heinrich M, Uder M, Tscholl D, Grgic A,Kramann B, Schafers HJ. CT scan findings in chronic thromboembolic pulmonary hypertension:predictors of hemodynamic improvement after pulmonary thromboendarterectomy. Chest. 2005;127:1606– 13.
13. Guthaner DF, Wexler L, Harell C. CT demonstration of cardiac structures. AJR Am J Roentgenol. 1979;133:75–81.
14. Kuriyama K, Gamsu G, Stern RG, Cann CE, Herfkens RJ, Brundage BH. CT-determined pulmonary artery diameters in predicting pulmonary hypertension. Invest Radiol. 1984;19:16 –22.
15. Haimovici JB, Trotman-Dickenson B, Halpern EF, Dec GW, Ginns LC, Shepard JA, et al. Relationship between pulmonary artery diameter at computed tomography and pulmonary artery pressures at right-sided heart catheterization. Massachusetts General Hospital Lung Transplantation Program. Acad Radiol. 1997;4:327–34.

16. Moore NR, Scott JP, Flower CD, Higenbottam TW. The relationship between pulmonary artery pressure and pulmonary artery diameter in pulmonary hypertension. Clin Radiol. 1988;39:486– 9.
17. Wittram C. The normal main pulmonary artery diameter. Br J Radiol. 2003;76:79.
18. Kruger S, Haage P, Hoffmann R, Breuer C, Bucker A, Hanrath P, et al. Diagnosis of pulmonary arterial hypertension and pulmonaryembolism with magnetic resonance angiography. Chest. 2001;120:1556–61.
19. Lang RM, Bierig M, Devereux RB, Flachskampf FA, Foster E, PellikkaPA, et al. Recommendations for chamber quantification. Eur J Echocardiogr. 2006;7:79–108.

Cite this article as: Wani AH, Shiekh Y, Ahangar NT. Main pulmonary artery diameter assessment in a large sample of Indian population: a MDCT based study. Int J Sci Rep 2019;5(6):145-9.