ORIGINAL RESEARCH ARTICLE

MEASUREMENT OF RIGHT PULMONARY ARTERY DIAMETER IN NORMAL CHEST RADIOGRAPHS

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ABSTRACT

Introduction: Many pathological condition and hypertension can be diagnosed by the measurement of the pulmonary artery. Our main objective was to measure the diameter of right pulmonary artery in normal chest radiographs. Methods: A cross-sectional study was performed in which, a total of 113 cases of chest radiographs were selected from July to October 2014, performed by qualified radiographer and reported by the radiologist. Right pulmonary artery is measured in Computed Radiography (CR) computer console. Obtained data were analyzed using in SPSS software version 20. Results: Among 113 cases, 52.2 % were male and 47.8 % were female. The mean diameter of the right pulmonary artery was found to be 11.96±2.04 mm, where in male, it was found to be 12.41 ± 2.0 mm and in female, it was found to be 11.46 ± 1.9 mm. The diameter of pulmonary artery was not correlated with height, weight, and BMI at 5% level of significance. Conclusion: This showed that female have narrower right pulmonary artery diameter than male. There was no significant relationship between pulmonary artery diameter and the height, weight and BMI. There was also no variation of measurement between male and female patients.

Key words: Chest radiograph, CR, Pulmonary artery

INTRODUCTION

Despite the rapid development of imaging technologies in recent years, the chest radiograph remains the most frequently performed radiographic examination. To obtain all the available information a systematic approach is required. The chest radiograph with its low radiation dose and relatively low expense is an easily repeatable examination.[1]

The pulmonary artery is a more compliant vessel than the systemic arterial system, and is thus more sensitive to changes in pressure and volume.[2] A variety of pulmonary artery dimensions have been explored to see if there is any association with both the presence and severity of pulmonary hypertension, including the pulmonary artery diameter, the cross-sectional area, the ratio of the diameter to the bronchus, the ratio of the diameter to the pulmonary vein, the ratio of diameter to the aortic diameter, and multiple regression methods assessing dimension of the main and branching pulmonary arteries. Based on such observations, we have found radiologists formally reporting on the pulmonary artery size and suggesting the presence or absence of pulmonary hypertension, which often has led to changes in clinical behaviour without a clear justification otherwise. The factors that determine the size of a vessel depend on several physiologic variables and any underlying pathology. Fundamentally, it is the volume of blood within the pulmonary artery that relates to the size of the pulmonary artery.

METHODS

A cross-sectional study was designed to get

maximum output in short time. A total number of 113 General Health Checkup patients referred to Radiology Department of Tribhuvan University Teaching Hospital (TUTH) for chest radiographic examination as a part of routine screening were chosen from July to October 2014. These radiographs were performed in upright erect position by using Hitachi x-ray machine with capacity 150 kV and 800 mA. The x-rays were performed with 70-110 kVp and 10-50 mAs using Computed Radiography image receptor (AGFA Company) of standard speed. The size of image receptor was 14"x14" with use of the vertical stand. These x-rays were processed in AGFA CR 30 readers. Patients of age group range from 10-85 years in both sexes were included. All radiographs were reported by the radiologist. For the data collection, a radiograph of chest PA view was taken. The radiographs of the patients presented at the department for radiographic assessment of the chest were reviewed and a proforma was made with the major expected measurements in chest x-rays and with observation methods, the findings were categorized and descriptive statistics were used to analyze the data.

Reported normal Chest radiograph of the patient who came for general health checkup was selected and diameter of the right pulmonary artery was measured. Measurement of the normal pulmonary artery can be done by following technique.

Techniques

a.   Central ray perpendicular to plane of film centred over mid chest

b.   Position: posteroanterior

c.   Target film distance: 6 feet

Measurements

All films were obtained in deep inspiration. The right lower lung field was utilized; a horizontal line was drawn from the descending branch of the right pulmonary artery just below the right hilar shadow to the lateral chest wall. A perpendicular line was then drawn inferiorly from the midpoint of this line to meet a horizontal line drawn bisecting the distance from the upper line and the cardio-phrenic

reflection. In this way, a central square-shaped area and the peripheral L-shaped area was obtained, and the diameter of the right descending artery was measured as it appeared below the right hilus. This measurement point was usually located between right 8th and 9th ribs posteriorly.

The quality of chest radiographs were evaluated under five criteria, viz., a) anatomical coverage (include entire lungs field from apex to dome of the diaphragm), b) arrested respiration (at least 6 anterior ribs above the right dome of the diaphragm), c) adequate penetration (slightly visible lower intervertebral disc below T9), d) no rotation (equidistant between the spine of the vertebra and sterno-clavicular joint), e) scapula out of lungs field (medial border of scapula out of lung) and all correct (met all mentioned above criteria). All the patients who came for the chest x-ray examination as a part of General Health Check-up (GHC) or routine screening and whose chest x-ray was reported normal by the radiologist. Patients below the age of 10 years, with previous cardiovascular disease, hypertensive and incompletely erect radiograph were excluded from the study.

RESULTS

Evaluation of right pulmonary diameter of collected chest radiographs in the study showed different values based on height, weight, sex and BMI. Among 113 data collected, 54 were female which constitutes 47.8% and 59 (52.2%) were male. According to this data, observed and calculated, the minimum age was 14 and maximum age was 85 years old. The mean age was 42.98 years. Similarly, minimum height of the patient was 135.5 cm and maximum height was 183.4 cm with the mean height 159.336 cm. Maximum weight of the patient was 88 kg whereas the minimum weight of the patient was 40 kg with the mean weight of 59.69 kg. Minimum was 15.96 and maximum was 32.09 with the mean BMI of 23.4616. Right pulmonary artery diameter measured was 7.10 mm minimum and 19.40 mm maximum with the mean pulmonary diameter of 11.9620 mm.

Table 1: Past surgery in cases of incisional hernia

	N	Minimum	Maximum	Mean	Std. Deviation
Age	113	14	85	42.98	14.098
Height (cm)	113	135.5	183.4	159.336	9.1748
Weight(Kg)	113	40	88	59.69	10.263
BMI	113	15.96	32.09	23.4616	3.20056
Diameter.PA(mm)	113	7.10	19.40	11.9620	2.04396

The mean pulmonary diameter in the male is found to be 12.41 mm whereas in the female it is found to be 11.46. It showed that the female has small sized pulmonary diameter than male. The comparison between male and female pulmonary diameter is further expressed in Figure 1.
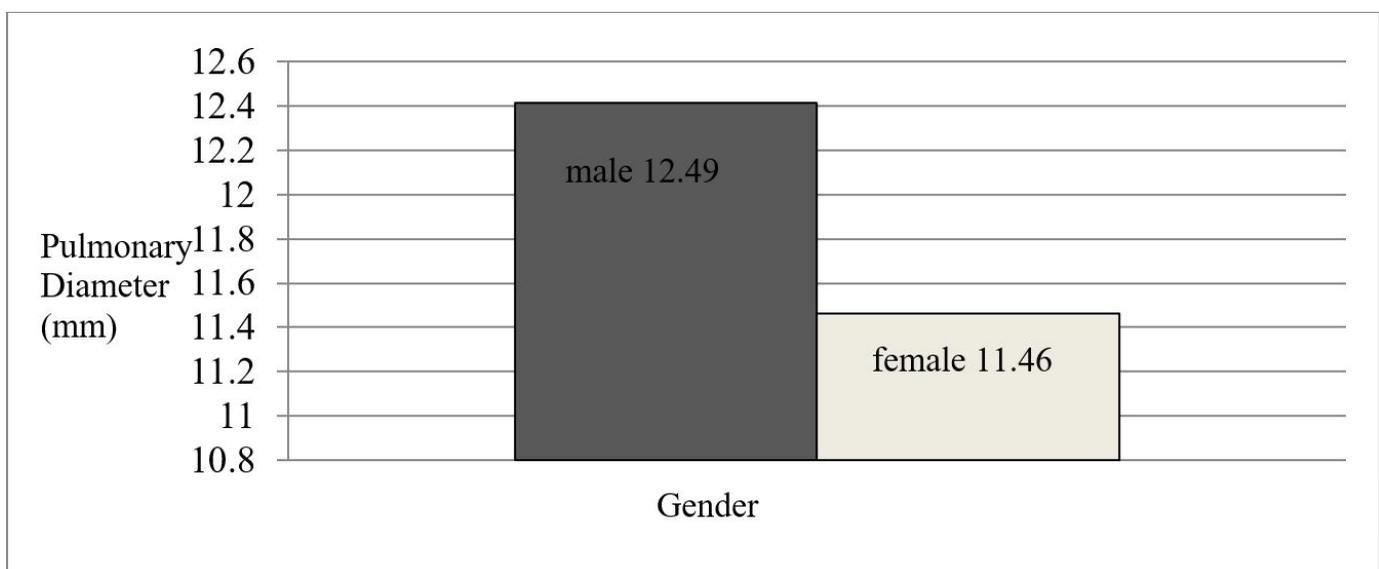

Fig 1: Bar diagram showing a comparison between male and female right pulmonary diameter.

There were only two male patients below 21 years of age and the mean pulmonary diameter was 13.6 mm. In age group (21 – 30), there were 10 male and 11 female patients and mean pulmonary diameter was 12.44 mm and 12.40 mm respectively. In the age group (31 – 40) years, there were 14 male and 16 female having diameters 11.78 mm and 11.55 mm respectively. In the age group (41 – 50) years, there were 12 males and 13 females with mean pulmonary diameter 11.19 mm and 11.52 mm respectively. Similarly, there were 11 males and 10 females in (51-60) age group and they have 13.35 mm and 10.57 mm in diameter respectively. Again, there is 7 males and 2 females in (61-70) age group having pulmonary diameter 14.24 mm and 9.7 mm respectively. There was 2 male and 1 female in (71-80) age group with pulmonary diameter 12.4 mm and 9.8 mm respectively. In (81-90) age group with 1 male and 1 female, the pulmonary diameter is 12.6 mm for male and 13.1 mm for female respectively. According to the statistical analysis, there was no correlation between BMI and pulmonary artery diameter as calculated value 0.609 > 0.05 at 5% level of significance. The height, as well as weight, was also not associated with pulmonary artery as the calculated value 0.931 > 0.05 and 0.677 > 0.05 respectively at 5% level of significance. There was also no variation between mean diameter of pulmonary artery between male and female patients according to age group at 5% level of significance.

DISCUSSION:

According to Atlas of Roentgenographic Measurement9, Theodore E.Keats, Lee B. Lusted, the diameter of the pulmonary artery in inspiration in the male is 16 mm and in expiration is 15 mm. In the female, the diameter of the pulmonary artery in inspiration is 15mm and in expiration is 14mm.9 In this present study, mean diameter of the pulmonary artery in male was found to be 12.41 mm and of a female was found to be 11.46 mm in full inspiration. In a study of Pulmonary artery diameters measured by multidetector-row CT in healthy adults6, Bozlar, Ors, Deniz, Uzun, Gumus, Ugurel, Yazar, and Tayfun showed that in 126 subjects aged between 19 and 46 years, having normal thoracic CTs (5-mm slice thickness) and normal pulmonary artery pressures (≤25 mmHg, determined by echocardiography), in which the diameters of the main, right, and left PAs were measured by using multidetector CT . They suggested that diameter of the main pulmonary artery and its main branches showed a normal distribution in subjects having normal pulmonary artery pressures. Based on the findings, the upper limits of the main, right, and left PA diameters are 29.5 mm, 19.8 mm, and 22.1 mm, respectively, in healthy adults. They found that the mean diameter of the right pulmonary artery was 11.96 ± 2.04 mm. Numerous studies have investigated the correlation between CT measurements of the pulmonary artery and the presence and severity of pulmonary hypertension.2,8,14 Overall, the measurement of the main pulmonary artery size by using CT shows a moderate to strong correlation with pH (r ~ 0.4–0.7). Further study is needed in the measurement of pulmonary artery diameter because it is directly related to many pathological conditions.

CONCLUSION

The diameter of the right pulmonary artery was found to be 11.96±2.04 mm, where the male had to mean right pulmonary artery diameter 12.41 mm and female 11.46 mm. This showed that female have narrower right pulmonary artery diameter than male. There was no significant relationship between pulmonary artery diameter and the height, weight and BMI. There was also no variation of measurement between male and female patients.

REFERENCES

1. Sutton David. The normal heart: anatomy and techniques of examination Textbook of Radiology and Imaging, Seventh Edition, Volume 1, 286 – 288.

2. Kamonpun Ussavarungsi, Joseph P. Whitlock, Taylor A. Lundy, Ivan D. Carabenciov, Charles D. Burger and Augustine S. Lee, The Significance of Pulmonary Artery Size in Pulmonary Hypertension, Diseases 2014;2:243-259; doi:10.3390/diseases2030243.

3. Guyton, M.D. Pulmonary Circulation, Pulmonary Edema, Pleural Fluid, Text Book of Medical Physiology eleventh edition, 483 – 484.

4. European Commission-Europeans Guidelines on quality criteria for diagnostic radiographic images, 1996; Brussels, Europeans commission.

5. ACR-SPR practical guidelines for the performance of pediatric and adult chest radiographs; ACR; revised 2011;1-5.

6. Bozlar, Ors, Deniz, Uzun, Gumus, Ugurel, Yazar, Tayfun. Pulmonary artery diameters measured by multidetector-row computed tomography in healthy adults, Acta Radiol. 2007;48(10):1086-91.

7. Truong Quynh, Massaro Joseph, Mahabadi Amir, Kriegel Matthias, Caroline S. Fox, J. O'Donnell Christopher, and Hoffmann Udo. Reference Values for Normal Pulmonary Artery Dimensions by Noncontrast Cardiac Computed Tomography Circ Cardiovasc Imaging. 2012;5(1):147–154. doi: 10.1161/CIRCIMAGING.111.968610.

8. Lundby Rigmor, Rand-Hendriksen Svend, Hald John K., Pripp Are Hugo & Smith Hans-Jorgen, The pulmonary artery in patients with Marfan syndrome Genetics in Medicine 2012;14:922–927.

9. Theodore E.Keats, Lee B. Lusted Atlas of Roentgenographic Measurement, Fifth edition

10. Moller, Pocket Atlas of Radiographic Anatomy, 2nd edition; Thieme, 2000;195.

11. Clark's Positioning in Radiography, 12th edition, Hodder Arnold publisher; Great Britain; 2005;180.

12. Merrill's Atlas of Radiographic Positioning and Radiological Procedure. 11th edition, volume 1; Mosby, 2007, 530.

13. Lusted LB, Keats TE. Atlas of roentgenographic measurement. Chicago: Year Book Medical Publishers; 1972.

14. Mirsadraee Majid, Nazemi Saeed, Hamedanchi Ali, Naghibi Saeed Simple Screening of Pulmonary Artery Hypertension Using Standard Chest X-Ray: An Old Technique, New Landmark National Research Institute of Tuberculosis and Lung Disease, Iran 28 May 2013.

10. Burger JW, Luijendijk RW, Hop WC, et al. Long term follow up of a randomized controlled trial of a suture versus mesh repair of incisional hernia. Ann Surg 2004;240 (4):578-85.

11. Scott NW, Graham P et al. Open mesh versus non-mesh repair of femoral and inguinal hernia. Cochrane Database syst Rev. 2002;(4):CD002197.

12. Van veen RN, Wijs muller AR, Vrij land WW et al. Long term follow up of a randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia. Brj Surg. 2007;94 (4):506-10.