THE UNIVERSITY OF ARIZONA College of Medicine Phoenix

CT Findings of Pulmonary Hypertension

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Abstract

Pulmonary hypertension is a disease with a poor prognosis. This study evaluates a potential correlation between CT findings and pulmonary hypertension diagnosed by right heart catheterization (RHC) and echocardiogram. This study is a retrospective review of subjects who underwent an otherwise unremarkable CT pulmonary artery angiogram. Subjects with pulmonary embolism, consolidation, or other radiographically-evident pulmonary disease are excluded. For each subject, the following CT findings are obtained: main pulmonary artery (mPA) diameter, ratio of mPA to ascending aorta (mPA:AA), right and left pulmonary artery diameters, ratio of segmental pulmonary artery to corresponding bronchus (sPA:B), and interventricular septal displacement. Data from 484 subjects are collected. Incidence rate of pulmonary hypertension is 13% (n=63). 52% (n=33) of the subjects with pulmonary hypertension are female with an average age of 55 years. mPA diameter (p<0.001), mPA:AA ratio (p<0.001), right (p<0.001) and left pulmonary artery (p=0.004) diameters are predictors of pulmonary hypertension. sPA:B ratio (p=0.08) and interventricular septal displacement (p=0.96) are not predictive of pulmonary hypertension. This study supports an association of mPA diameter, mPA:AA ratio, right and left pulmonary artery diameters with pulmonary hypertension diagnosed by RHC or echocardiogram.

Introduction

Primary pulmonary hypertension (PPH) is a severe disease that often implicates markedly decreased activity tolerance and eventually right sided heart failure. It has an incredibly poor prognosis; mean survival from time of diagnosis is only 2-3 years (4). PPH is defined hemodynamically by a mean pulmonary arterial pressure (mPAP) ≥ 25 mm Hg accompanied by pathological changes in the pulmonary precapillary vessels (3). The disease also has nonspecific presenting symptoms, similar to those of pulmonary embolism and multiple other cardiac/ pulmonary etiologies: shortness of breath, dyspnea on exertion, and/or chest pain.

Patients with PPH do have improved survival time with the new therapeutic strategies today (3). However, these therapeutic strategies are limited by their delayed implementation due to the late diagnosis of the disease. Explanations for delayed discovery of PPH in patients could be explained by the non-specific signs and symptoms of the disease itself and the limits of the diagnostic tools implemented.

Currently, right heart catheterization (RHC) remains the most accurate method of diagnosis (1). However, RHC is an invasive procedure with significant risks, requiring intensive monitoring and therefore limiting its use.

In addition to CT measurements already shown to have associations with PPH, we will be examining findings not yet fully described in the setting of PPH. Our ultimate plan is to develop a protocol based on our findings to prospectively recommend appropriate patient management.

Methods

We will be making the following CT measurements: mPAD, mPAD:AAD ratio, right pulmonary artery diameter, left pulmonary artery diameter, increased right ventricular septal pressure, ratio of segmental pulmonary arteries: corresponding segmental bronchi in the right lower lobe and left lower lobe. The CT measurements will be correlated with the mPAP measured on a prior/subsequent RHC or echocardiogram within 3 months of the CT pulmonary angiogram. Note: an mPAP ≥25mm Hg is defined as pulmonary hypertension.

Patient Selection

All patients presenting to the emergency department who underwent a CT pulmonary artery angiogram from October 1, 2013 to January 1, 2014 will be retrospectively examined for this study. Exclusion criteria will include causes of secondary PH such as a pulmonary embolism and other acute pulmonary diseases. Patient medical record numbers, date of births, gender, date of the CT, presence of connective tissue disease, and time difference between the RHC/echocardiogram and CT will be noted.

CT Technique

CT angiograms were taken of patients lying in the supine position during full inspiration. The CTs were performed using different scanners. The scans were read and analyzed using normal mediastinal windows. Helical CT scans were obtained with a 16-slice detector unit. 80-100 ml of non-ionic contrast were injected via 3ml/sec intravenously as part of the pulmonary angiogram protocol.

Interpretation

The CT scans will be examined by a radiologist and medical student as a blind study in which they will be unaware of the patient's diagnosis and RHC/echocardiogram readings.

Assessment

We will estimate the position of the interventricular septum on CT angiography axial images and grade it as normal (deviated to the right ventricle), straight, or bowing (deviated to the left ventricle). This will be indicative of the right ventricular pressures. Additionally, measurements of ≥29 mm for the mPAD will be considered as having a correlation with PPH.

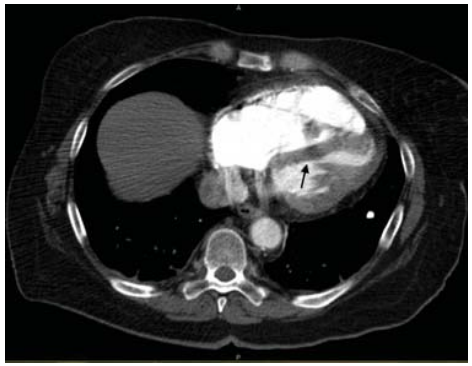

Figure 1: Black arrow shows straightening of the interventricular septum which is indicative of elevated Right ventricular pressures. The Right ventricle is enlarged as well.

Results

52% (n=33) of the subjects with pulmonary hypertension are female with an average age of 55 years. mPA diameter (p<0.001), mPA:AA ratio (p<0.001), right (p<0.001) and left pulmonary artery (p=0.004) diameters are predictors of pulmonary hypertension. sPA:B ratio (p=0.08) and interventricular septal displacement (p=0.96) are not predictive of pulmonary hypertension.

Group Statistics

	High PASP>=30	N	Mean	Std. Deviation	Std. Error Mean
Age	0	79	52.70	15.574	1.752
	1	63	55.08	11.959	1.507
Main PA	0	79	27.8861	4.56572	.51368
	1	63	30.7302	6.26358	.78914
PAD/AAD	0	79	.9238752223	.1570827578	.0176731910
	1	63	.9743166541	.1880590225	.0236932098
RPA	0	79	20.5696	2.92506	.32910
	1	63	23.4603	3.71928	.46859
LPA	0	79	20.6329	2.88309	.32437
	1	63	22.7778	3.42874	.43198
RLL A:B	0	79	1.515893811	.4289011675	.0482551514
	1	63	1.742326038	.6840145784	.0861777365
LLL A:B	0	79	1.4783	.56742	.06384
	1	63	1.6710	.65126	.08205

Table 1: Indicates the association of each variable with the PASP cutoff of greater than 30mmHg.

Discussion and Conclusions

This study supports an association of mPA diameter, mPA:AA ratio, right and left pulmonary artery diameters with pulmonary hypertension diagnosed by RHC or echocardiogram. Correlating CT findings with pulmonary hypertension allows clinicians to use CT as a noninvasive screening tool. Prospective research is warranted to confirm and establish threshold values for each variable.

Our study agrees with prior reports indicating that the size of the pulmonary arteries measured on CT does correlate with the incidence and severity of pulmonary hypertension. However, more specifically, our data indicated that the mPAD/AAD ratio had a higher correlation with pulmonary hypertension when compared to mPAD. The right pulmonary artery diameter and left pulmonary artery diameter showed significantly less correlation with the incidence of pulmonary hypertension; however, the left PAD indicated a better correlation than the left PAD. The other parameters we analyzed did not show significant correlation with pulmonary hypertension to suggest future use in a prediction model.

This research study is novel in analyzing the straightening of the interventricular septum relating to pulmonary hypertension. However, we were not able to detect straightening of the interventricular septum with enough incidence to have power. When straightening was detected, the patient did have pulmonary hypertension. Based on our limited data, this finding is not sensitive enough to be used as an evaluation of pulmonary hypertension though future studies are warranted.

Furthermore, we found that an mPAD/AAD ratio >1 and mPAD > or = 30 mm yielded the highest diagnostic accuracy. The combination of these two findings were able to detect pulmonary hypertension with relative accuracy. Using a higher threshold (>30 mm mPAD) lowered the sensitivity significantly but illustrated a greater specificity (~90%). This study supports an association of mPA diameter, mPA:AA ratio, right and left pulmonary artery diameters with pulmonary hypertension diagnosed by RHC or echocardiogram.

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