Original Article

Cardiac Etiology of PAH by Cardiac MDCT

Etiology of Pulmonary Arterial Hypertension Detected on Multi Detector Cardiac Computed Tomography in Patients with Primary Pulmonary Hypertension

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ABSTRACT

Objective: To determine the frequency of diagnosing cardiac etiology of PAH by cardiac MDCT in those patients who were labeled as primary pulmonary hypertension on echocardiography.

Study Design: Cross-sectional study

Place and Duration of Study: This study was conducted at the Computed Tomography Angiography Department, Punjab Institute of Cardiology, Lahore from May, 2019 to October 2020.

Materials and Methods: This study included 150 patients who were labeled as cases of primary PAH by echocardiography. All the patients underwent MDCT to look for any cardiovascular pathology as an etiologic factor of PAH (i.e. intracardiac shunting, valvular heart diseases, and cardiac source of thromboembolic PAH).

Results: MDCT could detect cardiac etiologies in 48(32%) patients. Intracardiac shunting was seen in 26(17.3%) patients, partial anomalous venous connection in 2(1.3%) patients, thromboembolic PAH in 18(12%) patients, valvular heart disease in 4(2.7%) patients, and no abnormality in 102(68%) patients.

Conclusion: MDCT could detect cardiac etiology in approximately one-third of patients who were labeled as PPH hypertension by echocardiography.

Key Words: Multidetector computed tomography; cardiac etiology; pulmonary hypertension

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INTRODUCTION

Right heart-catheterization showing precapillary PAH with a mean pulmonary artery pressure of >25 mmHg and atypical pulmonary artery wedge pressure of less than 15 mmHg is classified as pulmonary arterial hypertension. [1, 2]

Pulmonary hypertension (PAH) is a complicated and idiopathic condition, which can be associated with several diseases.

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The incremental loss of the pulmonary and arterial small arteries in patients with PAH leads to increased vascular resistance, which may potentially lead to correct ventricular failures and death.[3] Vasoconstriction, reshaping, and in situ thrombosis of the vascular wall are causes that increase vascular resistance. While the anatomy of the multiple clinical PAH classes is distinct, there are regular characteristics of media hypertrophy, intimate proliferation and fibrosis, and plexiform lesions.[4]

Because of unspecific symptoms and signs, the diagnosis of PAH may be skipped. Echocardiography is used for monitoring and diagnosis, however, right heart catheterization tests the normal gold pulmonary artery pressure and vasodilator response. The diagnosis of lung and underlying lung parenchymal disease is usually performed by computerized tomography angiography and HD CT. Chronic pulmonary arterial pressure rise allows the right atrium and ventricle pulmonary artery to be dilated. [5, 6]

A careful history of HAP risk factors, such as family history, history of medications and PAH contaminants, collagen-based vascular disorder, human immune virus, portal hypertension, congenital or left coronary disease, and venous thromboembolic disease, is important in evaluating them. [7] By using a variety of medical examinations to accommodate each particular patient,

the diagnosis and the correct determination of their etiology and severity, prognosis, clinical response, and PAH tracking, can be done in a fair measure. [8]

PAH is primarily marked where a secondary pulmonary and cardiac source is not present. With a median of 2.8 years and a 5-year survival rate of just 55%, mostly PAH estimates are low.[9]

Cardiac causes of PAH include multiple congenital and acquired cardiac diseases e.g. valvular heart disease, shunts, and cardiac source of pulmonary thromboembolism, almost all of these lesions have excellent short term results after surgical correction as well long term results.[10,11] Therefore diagnosing the cardiac etiology of PAH is very important but at the same time very challenging because there is no completely reliable non-invasive test for its detection.[12-15]

Echocardiography is usually relied upon for diagnosing the cardiac etiology of PAH. But advances in MDCT technology now permit accurate delineation of cardiac morphology and is widely utilized in the workup of both pulmonary and cardiac causes.[16, 17]

But very limited studies internationally regarding cardiac MDCT have been done for assessing its frequency in diagnosing cardiac etiology of PAH. One study was conducted by Grubstien et al., in which 38 patients with PAH, who underwent computed tomography, echocardiography, and other modalities, cardiac computed tomography was able to detect cardiac etiology of PAH in 23.6% of the patients.[18]

This study was conducted on a larger number of primary PAH patients than previous limited studies, and if cardiac computed tomography would be able to diagnose the cardiac etiologies of PAH insignificant number of patients which were missed on echocardiography than in future before labeling the patients as having primary PAH, which has a grave prognosis, patients will be referred for cardiac computed tomography and possibly more hidden cardiac pathologies will be diagnosed which are treatable, saving lives of many patients in this desperate group. The causes of pulmonary arterial hypertension (PAH) are diverse. The traditional role of computed tomography (CT) in evaluating PAH includes an assessment of pulmonary vasculature and lung parenchyma. However, advances in multi-detector CT (MDCT) technology may permit the delineation of cardiac morphology. This study was conducted to determine if cardiac CT would be able to diagnose cardiac etiologies of PAH which were missed on echocardiography.

MATERIALS AND METHODS

This cross-sectional study was conducted at the echocardiography and CT Angiography Department, Punjab Institute of Cardiology Lahore for six months from 11.05.2019 to 10.10.2020. The sample size of 150 cases was calculated with a 95% confidence level, 8% margin of error, and taking an expected percentage of detection of cardiac causes of PAH i.e. 25% on cardiac computed tomography in patients who were labeled as primary PAH on echocardiography. Patients aged 14-75years, of either gender, having PAH diagnosed without cardiac cause on echocardiography (transthoracic and transesophageal) were included in the study. The patients with PAH in which cardiac etiology e.g. intracardiac shunts, valvular heart disease, or cardiac origin of thromboembolism was not found on echocardiography were included in the study. Patients having any secondary cardiac cause of PAH detected on echocardiography, history of cardiac arrhythmias and heart failure, history of Chronic Obstructive Pulmonary Disease, history of acute or chronic renal failure creatinine level ≥1.5, and history of an allergic reaction to contrast reagent were not included in the study.

A total number of 150 patients diagnosed with PAH were selected from the echocardiography department and informed consent was taken. These patients then underwent cardiac MDCT angiography to look for any cardiovascular pathology as an etiologic factor of PAH. All echocardiographic studies were performed with the VIVID-07 echo machine. Standard 2-dimensional and color flow Doppler images were obtained in all patients. Computed tomography was performed with 64 slice MDCT. The outcome variables of my study were cardiac pathologies that include intracardiac shunting, valvular heart diseases, and cardiac source of thromboembolic PAH. Cardiac etiologies that were be detected on cardiac computed tomography are:

Intracardiac shunting: The abnormal flow of the blood between atria and ventricles.

Valvular heart disease: a mitral valve, aortic valve, pulmonary valve, and tricuspid valve abnormalities in the form of either stenosis, incompetence or both.

Thromboembolic PAH: the presence of thrombus or embolus in any chamber of the heart or pulmonary arterial vessels.

Data Analysis: Data was analyzed using SPSS version 21. The presence and absence of cardiac pathology on computed tomography angiography were presented by calculating frequency and percentage.

RESULTS

A total of 150 patients were included in this study based on inclusion criteria. The mean age of the patients was 35.11 $\pm$ 14.19 years [range 14 – 75 years]. There were 15 (10%) patients of the age range of 14 – 20 years, 61 (40.7%) patients of the age range of 21 – 30 years, 30 (20%) patients of the age range of 31 – 40 years, 21 (14%) patients of the age range of 41 – 50 years, 13 (8.7%) patients of the age range of 51 – 60 years, 5 (3.3%) patients of the age range of 61 – 70 years and 5 (3.3%) patients of the age range of 71 – 75 years. There were 61 (40.7%) male patients in the study, while 89

(59.3%) patients were female. The male to female ratio was 1:1.75. Table 1

The cardiac lesions were detected in 48 (32%) patients, while it was not detected in 1.2 (68%) patients. Figure 1 Out of 150 patients included in the study, intracardiac shunting was seen in 24(16%) patients, out of which 15 (10%) patients had patent ductus arteriosus and 9 (6%) patients had an atrial septal defect, partial anomalous venous connection in 2(1.3%) patients, thromboembolic PAH in 18(12%) patients, and valvular heart disease in 4 (2.7%) patients. Figure 2.

Table No.1: Demographic details of the patients (n=150)

Demographic variables	Number	Percentage
Gender		
Male	61	(40.7%)
Female	89	(59.3%)
Mean ± Age (in Years)	35.11 ± 14.19	
Age (in groups)		
14 – 20	15	(10%)
21 – 30	61	(40.7%)
31 – 40	30	(20%)
41 – 50	21	(14%)
51 – 60	13	(8.7%)
61 – 70	5	(3.3%)
71 – 75	5	(3.3%)

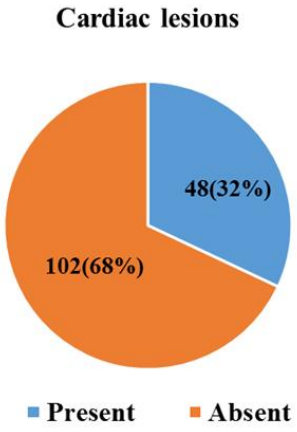

Figure No.1: Distribution of cardiac lesions (n = 150)

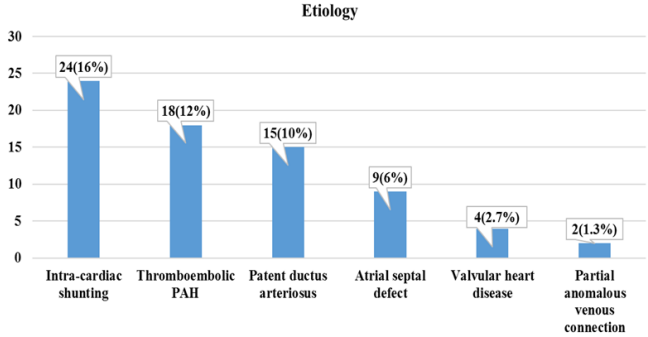

Figure No.2: Distribution of etiology of lesions in patients with positive cardiac lesions detected on MDCT (n = 150)

DISCUSSION

The etiology of PAH is diverse including idiopathic, pulmonary, or cardiac. The cardiac etiologies can be sufficiently diagnosed with an MDCT scan. This study was conducted to determine the frequency of cardia causes of PAH. This study was one of the largest studies conducted in this regard. Before this, no previous study is available which have documented the frequency of cardiac causes of PAH. The results of this study favored the use of MDCT scan for detection of cardiac causes of PAH as it could have detected the etiology in 32% cases.

The mean age of the patients in our study was 35.11±14.19 years. However, a much higher age of the patients was observed in the stud by Grubstein A, et al., who showed documented that the mean age of the patients with PAH was 52 years (range 20–80).[18] The results of our study showed that PAH was more frequent before 40 years of age. Approximately 70.7% of patients were below 40 years of age. In another study by Rich S, et al, it was observed that PAH was seen more frequently after the age of 60 years (28.2%).[19]

In our study, an MDCT scan could detect the cardiac etiology of the PAH in 32% of patients. The cardiac abnormalities were detected among those patients who were labeled on echocardiography as cases of primary PAH (i.e. idiopathic). In our study, thromboembolic PAH was the most common (12%) followed by patent ductus arteriosus (10%), rest others. Again, intracardiac shunting was the most frequent etiology (16%). However, we did not find any remarkable number of patients with valvular heart disease (2.7%), though, it is routinely, MDCT is usually performed when concomitant thoracic or pulmonary disorders, such as pulmonary embolism, are suspected. MDCT is a valuable alternative to cardiac magnetic resonance imaging in patients with a pacemaker, cardiac magnetic resonance imaging incompatible prosthetic material, and claustrophobia. Recent improvements in temporal and spatial resolution affected cardiac visualization. The use of MDCT for the right ventricular has mainly been validated for workup of PAH by other studies.

Echocardiography has a low sensitivity in diagnosing PE (60–70%) and is mainly used for risk stratification. One of the potential disadvantages of MDCT is that it cannot a routinely used technique due to the significant radiation exposure and the use of iodinated contrast medium. However, looking at the low sensitivity of echocardiography (60% - 70%), this appears to be beneficial over echocardiography with an advantage of minimally invasive technique.[20]

This study had certain limitations. This was a single-center study conducted in limited population size. Although findings of cardiac CT were evaluated by the senior radiologist, the findings were not confirmed by any other investigation and inter-observer variation in reading the CT reports was not also determined. This was an initial work for the utility of the MDCT scan, which has shown that it may be more helpful in the detection of cardiac etiology than echocardiography.

However, there is a need for conducting more studies in this regard before making any recommendation.

CONCLUSION

MDCT scan could detect the cardiac etiology in approximately one-third of the patients who were labeled as primary PAH by echocardiography. So, it shows that it may be a useful technology for the detection of etiology of cardiac origin among patients with primary PAH. However, more studies are required in large population sizes and at multiple centers before replacing it with standard diagnostic modalities like CT angiography or cardiac MRI.

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