

**Role of clinical medicine and radiology in the complication of pulmonary
hypertension**

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Abstract

Background:

Pulmonary Hypertension (PH) is a diversified group of entities affecting the pulmonary vasculature. Early detection is pivotal in the appropriate treatment of pulmonary hypertension. The initial and the simplest step in the detection of pulmonary hypertension is the performance of a combination of chest radiography, transthoracic Doppler echocardiography, and ECG.

Methodology:

An extensive literature review on the role of radiology and clinical medicine in pulmonary hypertension complication.

Results:

The study showed that Computed Tomography (CT) was the best imaging modality in the determination of the early onset of PH. Multiple clinical medicines like epoprostenol, nitric oxide, iloprost, and imatinib have been used to enhance and improve the exercise capacity, cardiac output, and hemodynamic function of the patient suffering from PH.

Conclusion:

No meaningful decrease in the time from the onset of symptoms to the PH diagnosis has been achieved in the last 20 years. However, multiple detection methods, such as the introduction of radiology and the use of texture-based lung graph models, have been slowly bridging this gap. Newer techniques in radiology will help in early detection of the disease and thus help in controlling it.

Keywords: Pulmonary hypertension, PH, CTEPH, radiology, clinical medicine

1. Introduction:

Pulmonary Hypertension (PH) is a diversified group of entities affecting the pulmonary vasculature. This group of diseases is able to secondarily affect the right heart via the production of a chronic increase in the pressure of the right heart, or the Left Ventricle's (LV) primary heart disease can become PH's secondary cause. The most accurate definition of PH would be a mean pulmonary artery pressure (mPAP) equal to or greater than 25 mm Hg, as determined through right heart catheterization. There are further classifications of the PH based on the additional parameters hemodynamically, with the inclusion of pulmonary wedge pressure and cardiac output. The recent most update in the different categories classification of PH is created on the conditions having the same pathologic and hemodynamic findings and management (François & Schiebler, 2016). The classification of PH is into five clinical subgroups: chronic thromboembolic PH (CTEPH), pulmonary arterial hypertension (PAH), PH due to chronic lung disease, PH due to the disease in the left-sided heart, and the PH having multifactorial/unclear mechanism. There are many underlying conditions and factors that might lead to the aforementioned disorders. Generally, approximately 1% of the population globally is afflicted with PH, and almost half of the patients suffering from heart failure might be affected by it. The routine tests performed in patients having physical findings and symptoms that are suggestive of PH include chest radiography, pulmonary function tests, and electrocardiography. For the estimation of PH probability, transthoracic echocardiography is also used. All the patients that have confirmed or suspected PH, without confirmation of lung disease or left-sided heart disease, need to have a scan of ventilation-perfusion for the exclusion of CTEPH (Mandras et al., 2020).

Early detection is pivotal in the appropriate treatment of pulmonary hypertension. The initial and the most straightforward step in the detection of pulmonary hypertension is the performance of a

combination of chest radiography, transthoracic Doppler echocardiography, and ECG. ECG is quite an excellent tool for screening of patients suspected of pulmonary hypertension involving the use of Doppler ultrasonography for measuring the systolic pulmonary arterial pressure and the tricuspid regurgitant jet velocity. For the detection of pulmonary hypertension, the specificity of 68% to 98% and sensitivity of 79% to 100% has been reported. Nevertheless, ECG is limited in the assessment of the right ventricle due to its orientation and shape (Peña et al., 2012). The World Symposia on Pulmonary Hypertension (WSPH) proceedings since 1973 have abridged the advances scientifically and the needs of the future in the field of Pulmonary Hypertension through multiple task forces' efforts, with each of the task force focusing on a diverse aspect of PH (Galiè et al., 2019).

2. Methodology:

The selected methodology for this article is the literature review of the present literature on the role of clinical medicine and radiology in pulmonary hypertension. The study explores the present literature on clinical medicine practices and radiology in the detection and treatment of pulmonary hypertension and its various types.

Inclusion and Exclusion Criteria:

The inclusion criteria for the research are based on factors that are relevant to the topic of the research;

- Complete relevance to the topic, such as the ones that discuss the role of radiology and clinical medicine in pulmonary hypertension.
- Literature reviews, doctoral dissertations, and reports which contain rigorous research.

The exclusion criteria for the research encompasses researches that do not address the current topic and researches.

3. Literature Review:

3.1.Role of Radiology:

3.1.1. Chest Radiograph:

The use of a chest radiograph is the most common in the imaging modality for the assessment of PH. The classical patterns radiographically of PH are the central pulmonary arteries enlargement (with the right interlobar pulmonary artery greater than 16 mm in men and greater than 15 mm in women)of peripheral arteries (with or without pruning). The dilatation of the right ventricle (RV) is observed in the advanced stages, with an enhancement of the posteroanterior (PA) radiograph and obliterating the retrosternal clear space from the radiograph laterally (RICH et al., 1987). The chest radiograph has been observed to show high specificity (99%) and sensitivity (97%) in the PH detection; however,PH is not excluded by a normal chest radiograph, especially in the patients suffering from mild disease. A chest radiograph is also valuable in diagnosing PH causes like ILD, left-heart disease, chest wall deformities, and emphysema(Miniati et al., 2014; Sirajuddin et al., 2017).

3.1.2. Computed Tomography (CT):

The most commonly used imaging modality in the assessment of PH is the CT, due to the excellent field-of-view, its higher spatial resolution, and the capabilities of multi-planar reconstruction; however, there is a radiation risk and risk of nephrotoxicity induced by iodinated contrast. The main pulmonary artery (MPA) having a diameter greater than or equal to 29 mm has 97% Pulse Pressure Variation (PPV) and 89% specificity in PH diagnosis(Tan et al., 1998).

A smaller diameter does not mean that PH is excluded entirely due to the low NPV. When the cut-off is amplified to 3.2 cm, the NPV can be increased by 90%, and specificity is able to be increased by 93%; however, there is a decrease in the sensitivity to 49% (Alhamad et al., 2011). In patients having ILD, the dilated MPA interpretation must be made cautiously, which can cause dilation of MPA due to the PH deprived traction and in the lung transplant following patients (Anand Devaraj et al., 2008). In patients with advanced ILD, especially the younger patients (less than 50 years of age) without aortic ectasia, another indicative of PH is the MPA diameter ratio to that of the ascending aorta in a similar axial plane of greater than or equal to 1.0 (A Devaraj & Hansell, 2009; Anand Devaraj et al., 2010; Ng et al., 1999). A 100% specificity in PH diagnosis is achievable in the diameter ration greater than 1:1 of the segmental artery-to-bronchus in the three or four lobes having a dilated MPA (Frazier & Burke, 2012). Prediction of mortality has also been shown by the primary right and left pulmonary arteries dilation greater than 18 mm. An egg and banana sign was described, with the visibility of the pulmonary artery at an aortic arch level and lateral to aortic arch (A Devaraj & Hansell, 2009; Tale et al., 2020). The MPA dilation can cause the adjacent structures' extrinsic compression like the left main coronary artery, recurrent laryngeal nerve, or the tracheobronchial tree (Kawut et al., 1999; Mesquita et al., 2004; Revel et al., 2009). The pulmonary artery distensibility decrease (less than 16.5%) on a retrospective ECG-gated CT provides an accurate and non-invasive PH marker, having a specificity of 96% and sensitivity of 85% (Revel et al., 2009; Zisman et al., 2007)

(Jimenez-del-Toro et al., 2020) presented a texture-based lung graph model for assessing the Pulmonary Embolism (PE) versus the Chronic thromboembolic pulmonary hypertension (CTEPH) testing and development in the examinations via CT. the approach presented outperformed clearly the deep learning approaches (by use of CNN0 that previously analyzed in

isolation the lung regions. Furthermore, the approach of a lung graph produced greater sensitivity than the known radiological findings of CT that were suggestive of PH (having PA:A ratio greater than 1). Combining the scores of lung graph together with the CT findings lead to an overall best performance in the differentiation amongst the CTEPH and acute PE cases, with the use of information obtained from CT scans.

3.2.Role of Clinical Medicine:

(Ghofrani et al., 2005) presented a report describing the use of a specified antagonist to the platelet-derived receptor of growth factor for pulmonary arterial hypertension (PAH) treatment. Daily oral administration of a 200 mg dosage of imatinib mesylate (Gleevec), a selective antagonist for the receptor of platelet-derived growth factor, approved for chronic myeloid leukemia treatment. Previous medications of the patient were also continued that included (iloprost, oral anticoagulants, diuretics, bosentan, and sildenafil), and the patient was closely monitored. After treatment with imatinib for three months, there was an impressive improvement in the condition of the patient, indicated by the improvement in the exercise capacity, improved functional class, and improved hemodynamics. The follow-up non-invasively after six months of the treatment revealed sustainable clinical efficacy and an improvement in the right ventricle performance as evaluated by ECG. The treatment showed no apparent side effects. (Hoepfer et al., 2000) conducted a study on the introduction of a stable prostacyclin analog, an aerosolized iloprost, as an alternative therapy for the severe condition of pulmonary hypertension. The study covered 24 patients that received a daily dose of 100 to 150 µg of aerosolized iloprost for at least one year. The results showed tremendous changes with the improvement in exercise capacity. Pulmonary arterial pressure before the inhalation also declined, the cardiac output increased, and the resistance by pulmonary vascular declined. The treatment was very well tolerated.

(Rubin & Peter, 1980) conducted a study for the analysis of hemodynamic effects on patients suffering from primary pulmonary hypertension. Hydralazine was administered orally 50 mg every six hours. The data was obtained from all the patients during exercise and rest. After the treatment through hydralazine, the overall rest pulmonary resistance decreased, the cardiac output increased, and the pulmonary arteriolar resistance decreased. There was also a decrease in the arteriovenous oxygen difference. The study concluded that hydralazine induced a permanent improvement in the hemodynamic function. (Barst et al., 1996) conducted a trial on the effects of the continual IV infusion of epoprostenol (formerly known as prostacyclin). Moreover, compare its effects with the effects of conventional therapy in patients suffering from a severe case of primary pulmonary hypertension. The trial went on for 12 weeks; it was observed in the study that the hemodynamics improved in the 12 weeks in patients that were treated with epoprostenol. A clinical trial was conducted by (Clark et al., 2000) for the determination of whether the low-dose inhalation of nitric oxide would result in the reduction of the use of extracorporeal membrane oxygenation in the neonates suffering from pulmonary hypertension born after 34 weeks gestation period, were four days old or younger than that, ones that had a hypoxemic respiratory failure (oxygenation index ≥ 25), and required assisted ventilation. Initially, the neonates received the nitric oxide treatment (20 ppm) for a maximum of twenty-four hours, which was followed by the treatment with five ppm for a maximum of ninety-six hours. It was concluded from the study that the development of chronic lung disease was lower in the neonates that were treated with nitric oxide as compared to the ones in the control group.

4. Results:

The results of the study showed that tools of radiology are quite common in the detection of Pulmonary hypertension, giving higher sensitivity and specificity. The study showed that

Computed Tomography (CT) was the best imaging modality in the determination of the early onset of PH. Multiple clinical medicines like epoprostenol, nitric oxide, iloprost, and imatinib have been used to enhance and improve the exercise capacity, cardiac output, and hemodynamic function of the patient suffering from PH.

5. Conclusion:

No meaningful decrease in the time from the onset of symptoms to the PH diagnosis has been achieved in the last 20 years. However, multiple detection methods, such as the introduction of radiology and the use of texture-based lung graph models, have been slowly bridging this gap. Newer techniques in radiology will help in early detection of the disease and thus help in controlling it. PH afflicts almost 1% of the global population; to date, no specified cure or remedy has been found except the use of clinical medicine to enhance the exercise capacity, hemodynamic function, and cardiac output of the patients.

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