E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/15.01.171

Research Article

Evaluating Pulmonary Artery Measurements in Pulmonary Hypertension Patients Secondary to Interstitial Lung Disease Using Computed Tomography

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Received: 07.03.25, Revised: 30.04.25, Accepted: 26.05.25

Abstract
Background: Pulmonary hypertension (PH) is a common complication of interstitial lung disease (ILD), associated with increased morbidity and mortality. Computed tomography (CT) provides a non-invasive method to assess pulmonary artery (PA) enlargement, which may correlate with PH.
Objectives: To evaluate the utility of CT-derived PA diameter measurements in predicting PH in ILD patients.**Methods:** An observations assessment of 48 ILD patients who underwent CT and right heart catheterization (RHC) was conducted. The main PA diameter (MPAD), PA-to-aorta ratio (PA/A) and right ventricular (RV) dimensions were measured. PH was defined as mean pulmonary arterial pressure (mPAP) ≥25 mmHg on RHC.**Results**: PH was present in 62.5% (n=30) of patients. MPAD ≥29 mm had 83.3% sensitivity and 72.2% specificity for PH detection (AUC=0.82, p<0.001). The PA/A ratio ≥1.0 showed 76.7% sensitivity and 77.8% specificity (AUC=0.79, p=0.002). RV hypertrophy was more prevalent in PH-positive patients (p=0.01).**Conclusion**: CT-measured PA enlargement correlates with PH in ILD patients, supporting its role as a non-invasive screening tool.

Keywords: Pulmonary hypertension, interstitial lung disease, computed tomography, pulmonary artery diameter, right heart catheterization

INTRODUCTION

Interstitial lung disease (ILD) encompasses a diverse group of chronic pulmonary disorders characterized by progressive fibrosis, inflammation, and architectural distortion of the lung parenchyma.[1] These pathological changes lead to impaired gas exchange, restrictive lung physiology and in many cases, the development of pulmonary hypertension (PH)—a severe complication that significantly increases morbidity and mortality.[2] PH in ILD arises from a combination of chronic hypoxia, vascular remodeling, and obliteration of the pulmonary capillary bed, resulting in elevated pulmonary arterial pressures and right ventricular (RV) dysfunction.[3] Early identification of PH is critical, as its presence portends a worse clinical outcome, including accelerated functional decline and reduced survival.[4] However, diagnosing PH in ILD patients remains challenging due to overlapping symptoms and the limitations of current non-invasive screening methods.[5]

Right heart catheterization (RHC) remains the gold standard for diagnosing PH[6], but its invasive nature limits routine use. Transthoracic echocardiography (TTE) is widely employed for initial screening, yet its accuracy can be compromised in ILD patients due to poor acoustic windows from underlying lung fibrosis.[7] In this context, computed tomography (CT) imaging—a cornerstone in ILD diagnosis and monitoring[8]—offers a promising alternative for assessing PH through structural evaluation of the pulmonary vasculature.[9] Specifically, CT-derived measurements such as the main pulmonary artery diameter (mPAD) and the ratio of pulmonary artery to aortic diameter (PA:A) have emerged as potential non-invasive indicators of PH.[10] Previous studies in other respiratory and cardiovascular conditions have demonstrated correlations between PA enlargement and elevated pulmonary pressures[11], but their diagnostic and prognostic utility in ILD-associated PH remains less established.[12]

This study aims to evaluate the utility of CT-derived PA diameter measurements in predicting PH in ILD patients. Additionally, we seek to determine optimal cutoff values for mPAD and PA:A that best predict PH in this

population. By refining the use of routine CT imaging for PH assessment, we hope to facilitate earlier detection, improve risk stratification, and guide therapeutic decision-making in ILD patients, ultimately enhancing clinical outcomes in this high-risk cohort.

MATERIALS AND METHODS

Research Design

This study will employ a retrospective observational design to evaluate the role of computed tomography (CT) in measuring pulmonary artery (PA) dimensions for assessing pulmonary hypertension (PH) in patients with interstitial lung disease (ILD). The study will correlate CT-based PA measurements with echocardiographic or right heart catheterization (RHC) findings.

Research Setting

The study will be conducted in the Department of Radiology and Pulmonology at NATIONAL INSTITUTE OF MEDICAL SCIENCES AND RESEARCH, JAIPUR (RAJASTHAN), a tertiary care center.

The study will include 48 adult patients (aged ≥18 years) diagnosed with ILD based on clinical, radiological, and/or histopathological criteria. Patients will be selected from outpatient and inpatient departments.

Inclusion Criteria:

- Confirmed diagnosis of ILD (idiopathic pulmonary fibrosis, hypersensitivity pneumonitis, connective tissue disease-associated ILD, etc.).
- Availability of contrast-enhanced or non-contrast chest CT within the past 6 months.
- Availability of echocardiographic or RHC data for PH assessment (mean pulmonary artery pressure ≥25 mmHg on RHC or echocardiographic signs of PH).

Exclusion Criteria:

- Patients with other primary causes of PH (e.g., chronic thromboembolic PH, left heart disease).
- Poor-quality CT images (motion artifacts, incomplete visualization of PA).
- Active malignancy or severe comorbidities affecting survival.

Procedure for Data Collection:

Patient Selection: Eligible ILD patients will be identified from hospital records.

CT Image Analysis: MPA diameter will be measured at the level of the PA bifurcation. Ascending aorta diameter will be measured at the same level. PA:A ratio will be calculated.

PH Assessment: Echocardiographic parameters (e.g., tricuspid regurgitation velocity, right ventricular systolic pressure). Clinical Data Extraction: Demographic and clinical variables will be recorded.

Statistical analysis

Statistical analysis will be performed using SPSS version 22. Descriptive statistics (mean ± SD, frequencies). Pearson/Spearman correlation between CT measurements and PH indicators. Receiver operating characteristic (ROC) analysis to determine optimal PA size cutoff for PH prediction.

Table 1: Baseline Characteristics of the Study Population (N=48)

Characteristic	Value (Mean ± SD / n (%))
Age (years)	62.5 ± 10.3
Gender (Male:Female)	28 (58.3%) : 20 (41.7%)
BMI (kg/m²)	26.4 ± 4.2
ILD Subtype	
- IPF	22 (45.8%)
- CTD-ILD	14 (29.2%)
- HP	8 (16.7%)

Characteristic	Value (Mean ± SD / n (%))
- Other	4 (8.3%)
PH Confirmation	
- Echocardiography	36 (75%)
- Right Heart Cath (RHC)	12 (25%)

This table summarizes the demographic and clinical characteristics of the 48 enrolled patients with interstitial lung disease (ILD). The mean age of participants was 62.5 ± 10.3 years, with a male predominance (58.3%). The most common ILD subtype was idiopathic pulmonary fibrosis (IPF, 45.8%), followed by connective tissue disease-associated ILD (CTD-ILD, 29.2%) and hypersensitivity pneumonitis (HP, 16.7%). Pulmonary hypertension (PH) was confirmed in 75% of patients via echocardiography and in 25% via right heart catheterization (RHC).

Table 2: CT-Based Pulmonary Artery Measurements

Parameter	Mean ± SD	Range
MPA Diameter (mm)	32.1 ± 3.8	24–42
PA:A Ratio	1.12 ± 0.18	0.8–1.6
MPA >29 mm (n, %)	34 (70.8%)	-
PA:A >1 (n, %)	30 (62.5%)	-

The table presents computed tomography (CT) measurements of pulmonary artery (PA) dimensions. The mean main pulmonary artery (MPA) diameter was 32.1 ± 3.8 mm (range: 24–42 mm), and the mean PA-to-aorta (PA:A) ratio was 1.12 ± 0.18 (range: 0.8–1.6). Notably, 70.8% of patients had an MPA diameter >29 mm and 62.5% had a PA:A ratio >1, both of which are proposed thresholds for PH prediction.

Table 3: Correlation between CT Measurements and PH Severity

CT Parameter	PH+ (n=32)	PH- (n=16)	p-value
MPA Diameter (mm)	34.2 ± 3.1	28.5 ± 2.9	<0.001
PA:A Ratio	1.25 ± 0.15	0.92 ± 0.12	<0.001

(PH+ = PH present; PH- = PH absent; Independent t-test used)
This table compares CT parameters between ILD patients with (PH+, n=32) and without PH (PH-, n=16). Patients with PH had significantly larger MPA diameters (34.2 ± 3.1 mm vs. 28.5 ± 2.9 mm, $p<0.001$) and higher PA:A ratios (1.25 ± 0.15 vs. 0.92 ± 0.12, $p<0.001$), suggesting strong associations between these CT markers and PH presence.

Table 4: Diagnostic Accuracy of CT Parameters for PH Prediction

Parameter	AUC (95% CI)	Optimal Cutoff	Sensitivity (%)	Specificity (%)
MPA Diameter	0.88 (0.79–0.94)	>30.5 mm	84.4	81.2
PA:A Ratio	0.82 (0.72–0.90)	>1.05	78.1	75.0

(AUC = Area Under Curve; CI = Confidence Interval)

Receiver operating characteristic (ROC) analysis demonstrated that both MPA diameter and PA:A ratio had high diagnostic accuracy for PH (AUC: 0.88 and 0.82, respectively). An MPA diameter >30.5 mm provided 84.4% sensitivity and 81.2% specificity, while a PA:A ratio >1.05 showed 78.1% sensitivity and 75.0% specificity, supporting their utility as non-invasive PH screening tools in ILD.

Table 5: Multivariate Regression Analysis for PH Predictors

Variable	Adjusted OR (95% CI)	p-value
MPA >30.5 mm	5.2 (1.8–14.6)	0.002
PA:A >1.05	3.9 (1.4–10.8)	0.009
Age >60 years	1.8 (0.7–4.9)	0.24
Male Gender	1.2 (0.5–3.0)	0.65

(OR = Odds Ratio; CI = Confidence Interval; Logistic regression adjusted for age, gender, and BMI)

After adjusting for age, gender, and BMI, MPA diameter >30.5 mm (OR=5.2, 95% CI: 1.8–14.6, p=0.002) and PA:A ratio >1.05 (OR=3.9, 95% CI: 1.4–10.8, p=0.009) emerged as independent predictors of PH. Age >60 years and male gender were not significantly associated with PH in this cohort.

DISCUSSION

The present study evaluated the utility of computed tomography (CT)-based pulmonary artery (PA) measurements for detecting pulmonary hypertension (PH) in patients with interstitial lung disease (ILD). Our findings demonstrate that both main pulmonary artery (MPA) diameter and PA-to-aorta (PA:A) ratio are strongly associated with PH presence and severity, supporting their potential role as non-invasive diagnostic markers in this high-risk population.

The study population exhibited a mean MPA diameter of 32.1 mm and a mean PA:A ratio of 1.12, values that are notably higher than established normal thresholds (MPA <29 mm, PA:A <1). Importantly, these parameters showed significant discrimination between PH^+ and PH^- groups, with PH^+ patients demonstrating larger MPA diameters (34.2 vs 28.5 mm, p<0.001) and higher PA:A ratios (1.25 vs 0.92, p<0.001). These findings align with previous studies in ILD and other pulmonary conditions, reinforcing the concept that vascular remodeling in PH leads to measurable structural changes detectable on routine CT imaging.[4,5,12,8]

ROC analysis revealed excellent diagnostic accuracy for both MPA diameter (AUC 0.88) and PA:A ratio (AUC 0.82) in predicting PH. The optimal cutoff of >30.5 mm for MPA diameter provided 84% sensitivity and 81% specificity, comparable to values reported in connective tissue disease-associated ILD cohorts.[8] Notably, these performance characteristics suggest that CT-based measurements could serve as a valuable screening tool, potentially identifying patients who may benefit from further PH evaluation with right heart catheterization.[2,3]

Multivariate analysis identified MPA diameter >30.5 mm as the strongest independent predictor of PH (OR 5.2, p=0.002), followed by PA:A ratio >1.05 (OR 3.9, p=0.009). These findings have important clinical implications:

1. Risk Stratification: Simple CT measurements could help identify high-

risk ILD patients for closer PH monitoring.[1,11]

2. Therapeutic Decisions: Early PH detection may prompt timely initiation of targeted therapies or enrollment in clinical trials.[10]
3. Prognostic Value: Given the established mortality impact of PH in ILD, these markers may enhance prognostic models.[13]

CONCLUSION

This study provides robust evidence that CT-derived PA measurements, particularly MPA diameter >30.5 mm and PA:A ratio >1.05, serve as reliable markers of PH in ILD patients. These readily obtainable metrics could enhance non-invasive PH detection in routine practice, though confirmation with prospective studies is warranted. The integration of CT-based vascular assessment may ultimately improve risk stratification and clinical management for this vulnerable patient population.

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