



Original Research Article

Study of Right Ventricular Dysfunction in Patients with Chronic Obstructive Pulmonary Disease Using Echocardiography

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Abstract

Background :Chronic obstructive pulmonary disease (COPD) is a progressive respiratory disorder associated with significant cardiovascular complications, particularly right ventricular (RV) dysfunction due to chronic hypoxia, pulmonary vascular remodeling, and increased pulmonary vascular resistance. Early detection of RV impairment is essential for risk stratification and management. Echocardiography provides a non-invasive approach for evaluating right ventricular structure and function in COPD patients.

Aim :The present study aimed to assess right ventricular dysfunction among patients with COPD using echocardiographic parameters and to evaluate its association with disease severity and serum CA125 levels.

Materials and Methods :This prospective observational study included 70 patients with COPD. All participants underwent detailed clinical assessment, spirometric evaluation, serum CA125 estimation, and transthoracic echocardiography. Right ventricular function was assessed using parameters including tricuspid annular plane systolic excursion (TAPSE), right ventricular fractional area change (RVFAC), tissue Doppler-derived systolic velocity (S'), right ventricular myocardial performance index (MPI), and pulmonary artery systolic pressure (PASP).

Results :The mean age of participants was 61.8 ± 8.6 years, with male predominance (82.9%). Right ventricular dysfunction was identified in 24 (34.3%) patients. Patients with RV dysfunction demonstrated significantly lower TAPSE (15.2 ± 2.1 mm vs 19.8 ± 2.9 mm; $p < 0.001$), reduced RVFAC ($29.8 \pm 5.6\%$ vs $39.8 \pm 6.2\%$; $p < 0.001$), and higher PASP (55.6 ± 10.8 mmHg vs 31.6 ± 7.5 mmHg; $p < 0.001$) compared with patients having preserved RV function. RV dysfunction was significantly associated with advanced COPD severity. Serum CA125 levels were significantly elevated among patients with RV dysfunction (48.6 ± 18.9 vs 24.8 ± 10.6 U/mL; $p < 0.001$).

Conclusion :Right ventricular dysfunction is a common cardiovascular manifestation in COPD and is associated with disease severity, elevated pulmonary artery pressure, and increased CA125 levels. Echocardiographic assessment provides a valuable, non-invasive method for early detection of RV involvement and may improve prognostic evaluation and clinical management of COPD patients.

Keywords :Chronic obstructive pulmonary disease; Right ventricular dysfunction; Echocardiography; TAPSE; Pulmonary hypertension; CA125; Right heart failure.

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Introduction

Chronic obstructive pulmonary disease (COPD) is a common, progressive respiratory disorder characterized by persistent respiratory symptoms,

chronic airway inflammation, and irreversible airflow limitation due to abnormalities of the airways and alveolar structures. It remains one of the

leading causes of morbidity and mortality worldwide and represents a major global health burden.[1] Although primarily considered a pulmonary disease, COPD is associated with significant systemic effects, particularly cardiovascular complications, which contribute substantially to disease progression, hospitalization, and mortality. Cardiovascular involvement in COPD occurs due to chronic hypoxia, pulmonary vascular remodeling, endothelial dysfunction, and increased pulmonary vascular resistance. These changes lead to the development of pulmonary hypertension, resulting in chronic pressure overload on the right ventricle (RV).[2] Persistent stress on the right ventricle may cause compensatory hypertrophy, progressive dilatation, impaired contractility, and eventually right-sided heart failure or cor pulmonale. Right ventricular dysfunction is an important determinant of functional limitation and prognosis in COPD patients and is associated with reduced exercise tolerance, increased exacerbations, and adverse clinical outcomes.[3] The right ventricle plays a critical role in maintaining pulmonary circulation and is highly influenced by changes in pulmonary vascular resistance. In COPD, chronic hypoxemia and destruction of pulmonary vascular beds contribute to structural and functional alterations of the RV. [4] Importantly, subclinical right ventricular dysfunction may develop before the appearance of overt signs of right heart failure, emphasizing the importance of early detection for risk assessment and appropriate management. Echocardiography is a widely available, non-invasive modality for evaluating right ventricular structure and function in patients with COPD. It provides valuable information regarding RV size, systolic function, pulmonary artery pressure, and associated cardiac abnormalities.[5] Parameters such as tricuspid annular plane systolic excursion (TAPSE), right ventricular fractional area change (RVFAC), tissue Doppler-derived systolic velocity (S'), right ventricular myocardial performance index (MPI), and pulmonary artery systolic pressure estimation are commonly used for assessment of RV function. Advanced echocardiographic techniques, including tissue Doppler imaging and speckle-tracking echocardiography, have further enhanced the ability to identify early abnormalities in right ventricular mechanics.[6] However, assessment of RV function in COPD patients remains challenging due to the complex geometry of the right ventricle, dependence on loading conditions, and technical limitations caused by lung hyperinflation and altered thoracic anatomy.[7] Therefore, a comprehensive evaluation using multiple echocardiographic parameters is essential for accurate assessment of right ventricular involvement. In addition to imaging modalities, biomarkers reflecting cardiovascular stress and systemic inflammation have gained attention in chronic cardiopulmonary diseases.[8]

Carbohydrate antigen 125 (CA125), traditionally used as a tumor marker, has been increasingly recognized for its role in non-malignant conditions associated with inflammation, fluid overload, and cardiovascular dysfunction. Elevated CA125 levels have been reported in patients with heart failure and are considered to reflect hemodynamic stress, increased intracardiac pressure, and systemic congestion.[9] Emerging evidence suggests that CA125 may also have potential relevance in assessing disease severity and cardiovascular involvement in patients with COPD. Since progression of COPD is closely associated with pulmonary hypertension and right ventricular dysfunction, evaluation of echocardiographic parameters along with relevant biomarkers may provide additional information regarding cardiopulmonary interactions and disease severity.[10] Early identification of RV impairment may help in prognostic stratification, optimization of treatment strategies, and prevention of advanced cardiovascular complications. The present study titled "Study of Right Ventricular Dysfunction in Patients with Chronic Obstructive Pulmonary Disease Using Echocardiography" aims to evaluate right ventricular structural and functional changes in COPD patients using echocardiographic parameters and to assess their association with disease severity and clinical characteristics. Improved recognition of right ventricular dysfunction may contribute to better management and outcomes among patients with COPD.

Methodology:

The present study was conducted as a prospective observational study to evaluate right ventricular dysfunction among patients with chronic obstructive pulmonary disease (COPD) using echocardiographic assessment. A total of 70 patients diagnosed with COPD were included in the study. Patients were selected according to predefined inclusion and exclusion criteria. All participants underwent detailed clinical evaluation, pulmonary assessment, biochemical investigations, and transthoracic echocardiographic examination for assessment of right ventricular structure and function.

Inclusion Criteria

Patients fulfilling the following criteria were included in the study:

- Patients aged ≥ 40 years.
- Patients diagnosed with COPD according to clinical history, examination findings, and spirometric criteria.
- Patients with documented airflow limitation with post-bronchodilator FEV_1/FVC ratio < 0.70 .

- Patients who were clinically stable and willing to participate in the study.
- Patients who provided written informed consent.

Exclusion Criteria

Patients with the following conditions were excluded from the study:

- Patients with acute exacerbation of COPD at the time of evaluation.
- Patients with known congenital heart disease or significant valvular heart disease.
- Patients with left ventricular systolic dysfunction or established heart failure.
- Patients with ischemic heart disease or previous myocardial infarction.
- Patients with pulmonary diseases other than COPD that could affect pulmonary pressures.
- Patients with malignancy or other conditions known to influence serum CA125 levels.
- Patients unwilling to participate in the study.

Clinical Evaluation

All enrolled patients underwent detailed clinical evaluation, including demographic assessment, respiratory symptoms, smoking history, duration of COPD, and previous history of exacerbations or hospitalization. A complete physical examination was performed with special emphasis on signs suggestive of pulmonary hypertension and right heart involvement, including peripheral edema, raised jugular venous pressure, cyanosis, and features of right-sided heart failure. The severity of COPD was assessed based on pulmonary function testing and classified according to established severity criteria. Spirometric parameters, including forced expiratory volume in one second (FEV₁), forced vital capacity (FVC), and FEV₁/FVC ratio, were recorded.

Laboratory Investigations

Venous blood samples were collected from all participants for routine biochemical investigations. Serum CA125 levels were measured using an appropriate immunoassay technique. Additional investigations, including complete blood count, renal function tests, liver function tests, and other relevant parameters, were performed as clinically indicated.

Echocardiographic Assessment

All patients underwent transthoracic echocardiographic evaluation using a standard echocardiography system. The examination was

performed by an experienced echocardiologist according to recommended guidelines.

The following parameters were assessed:

- Right ventricular size and morphology.
- Right ventricular systolic function.
- Tricuspid annular plane systolic excursion (TAPSE).
- Right ventricular fractional area change (RVFAC).
- Tissue Doppler-derived tricuspid annular systolic velocity (S').
- Right ventricular myocardial performance index (MPI).
- Pulmonary artery systolic pressure (PASP).
- Presence of right ventricular dilatation, hypertrophy, or features suggestive of cor pulmonale.

Right ventricular dysfunction was defined based on echocardiographic evidence of impaired RV systolic function according to standard reference criteria.

Study Outcomes

The primary outcome of the study was assessment of the prevalence of right ventricular dysfunction among COPD patients using echocardiographic parameters.

Secondary outcomes included:

- Correlation of right ventricular dysfunction with severity of COPD.
- Association between echocardiographic parameters and clinical characteristics.
- Evaluation of serum CA125 levels in relation to right ventricular dysfunction.
- Assessment of factors associated with increased risk of RV impairment.

Statistical Analysis

The collected data were entered into a Microsoft Excel spreadsheet and analyzed using SPSS .21 statistical software. Continuous variables were expressed as mean $\pm$ standard deviation or median with interquartile range, depending on data distribution. Categorical variables were presented as frequencies and percentages. Comparison between groups was performed using the independent sample t-test or Mann-Whitney U test for continuous variables and Chi-square test or Fisher's exact test for categorical variables. Correlation between echocardiographic parameters, clinical variables, and biochemical markers was assessed using Pearson's or Spearman's correlation coefficient as appropriate. A p-value of <0.05 was considered statistically significant.

Results:

The present study included 70 patients with chronic obstructive pulmonary disease (COPD) who

underwent clinical assessment, spirometric evaluation, serum CA125 estimation, and transthoracic echocardiographic examination for assessment of right ventricular (RV) structure and function.

The mean age of the study population was 61.8 ± 8.6 years. The majority of patients belonged to the 60–69 years age group (51.4%). A marked male predominance was observed, with 58 (82.9%) males and 12 (17.1%) females. Smoking history was present in 62 (88.6%) patients, reflecting the strong association between tobacco exposure and COPD. The most common presenting symptom was exertional dyspnea, observed in 70 (100%) patients, followed by chronic cough in 52 (74.3%) patients and sputum production in 48 (68.6%) patients. Previous COPD exacerbation requiring hospitalization was reported in 28 (40.0%) patients. The demographic and clinical profile of study participants is presented in Table 1.

Table 1: Demographic and Clinical Characteristics of Study Participants (n=70)

Parameter	Number (%) / Mean $\pm$ SD
Age (years)	61.8 $\pm$ 8.6
40–49 years	6 (8.6%)
50–59 years	18 (25.7%)
60–69 years	36 (51.4%)
≥ 70 years	10 (14.3%)
Male	58 (82.9%)
Female	12 (17.1%)
Smoking history	62 (88.6%)
Duration of COPD (years)	8.4 $\pm$ 4.1
Exertional dyspnea	70 (100%)
Chronic cough	52 (74.3%)
Sputum production	48 (68.6%)
Previous hospitalization due to exacerbation	28 (40.0%)

Based on spirometric evaluation, patients were categorized according to GOLD classification. Moderate and severe COPD constituted the majority of cases. GOLD stage II COPD was observed in 26 (37.1%) patients, followed by GOLD stage III in 24 (34.3%) patients. Very severe COPD (GOLD IV) was present in 12 (17.1%) patients.

The distribution of patients according to COPD severity is shown in Table 2, Figure 1

Table 2: Distribution of Patients According to COPD Severity (n=70)

GOLD Stage	Number (%)
GOLD I (Mild)	8 (11.4%)
GOLD II (Moderate)	26 (37.1%)
GOLD III (Severe)	24 (34.3%)
GOLD IV (Very severe)	12 (17.1%)

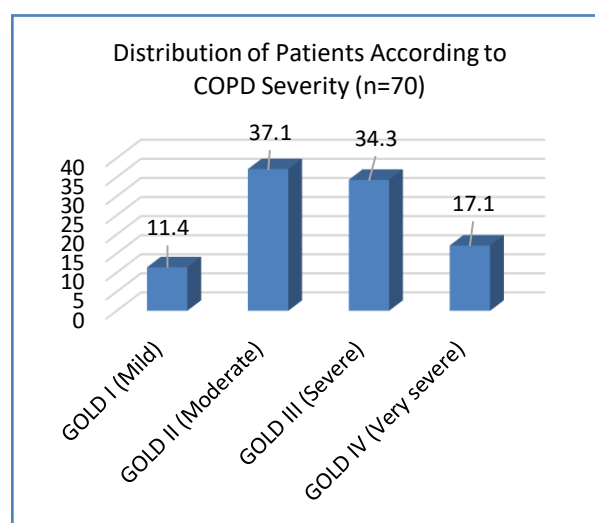


Figure 1 Distribution of Patients According to COPD Severity (n=70)

Echocardiographic evaluation revealed evidence of right ventricular structural and functional alterations among COPD patients. The mean pulmonary artery systolic pressure (PASP) was 39.8 ± 12.6 mmHg. The mean TAPSE value was 18.2 ± 3.5 mm, while reduced TAPSE (<17 mm), suggestive of impaired RV systolic function, was observed in 24 (34.3%) patients.

The mean RVFAC was $36.4 \pm 7.8\%$, and reduced RVFAC was observed in 22 (31.4%) patients. The echocardiographic parameters are summarized in Table 3.

Table 3: Echocardiographic Parameters of Right Ventricular Function (n=70)

Echocardiographic Parameter	Value
RV basal diameter (mm)	39.6 $\pm$ 5.8
TAPSE (mm)	18.2 $\pm$ 3.5
TAPSE <17 mm	24 (34.3%)

RVFAC (%)	36.4 ± 7.8
RVFAC <35%	22 (31.4%)
S' velocity (cm/s)	10.8 ± 2.1
S' velocity <9.5 cm/s	18 (25.7%)
PASP (mmHg)	39.8 ± 12.6
RV MPI	0.46 ± 0.12

Based on echocardiographic assessment, right ventricular dysfunction was identified in 24 (34.3%) patients, whereas 46 (65.7%) patients had preserved RV function.

Patients with RV dysfunction demonstrated significantly lower TAPSE, RVFAC, and S' velocity values along with higher PASP and RV MPI compared with patients without RV dysfunction. The comparison between the two groups is presented in Table 4, Figure 2

Table 4: Comparison of Echocardiographic Parameters Between Patients With and Without RV Dysfunction

Parameter	RV Dysfunction Present (n=24)	RV Dysfunction Absent (n=46)	p-value
TAPSE (mm)	15.2 ± 2.1	19.8 ± 2.9	<0.001
RVFAC (%)	29.8 ± 5.6	39.8 ± 6.2	<0.001
S' velocity (cm/s)	8.9 ± 1.4	11.8 ± 1.8	<0.001
PASP (mmHg)	55.6 ± 10.8	31.6 ± 7.5	<0.001
RV MPI	0.62 ± 0.11	0.38 ± 0.08	<0.001

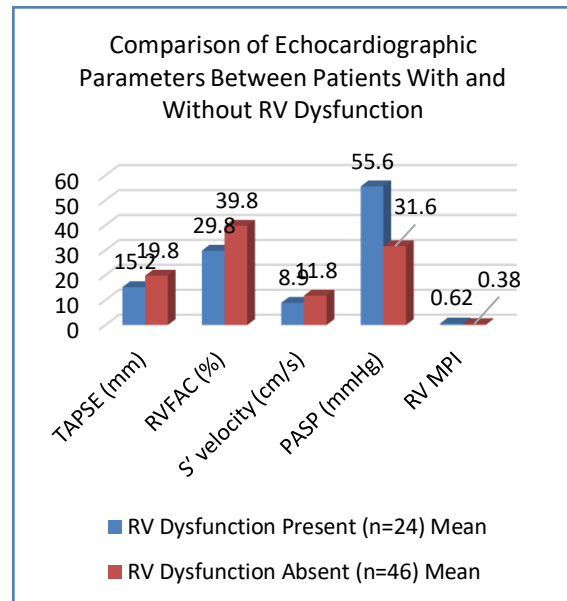


Figure 2 Comparison of Echocardiographic Parameters Between Patients With and Without RV Dysfunction

A significant association was observed between increasing COPD severity and development of RV dysfunction. RV dysfunction was present in 50.0% of patients with GOLD IV disease and 41.7% of patients with GOLD III disease, compared with only 12.5% among GOLD I patients (p=0.032).

The relationship between COPD severity and RV dysfunction is presented in Table 5, Figure 3

Table 5: Association Between COPD Severity and Right Ventricular Dysfunction (n=70)

GOLD Stage	RV Dysfunction Present	RV Dysfunction Absent
GOLD I	1 (12.5%)	7 (87.5%)
GOLD II	7 (26.9%)	19 (73.1%)
GOLD III	10 (41.7%)	14 (58.3%)
GOLD IV	6 (50.0%)	6 (50.0%)
p-value	0.032	

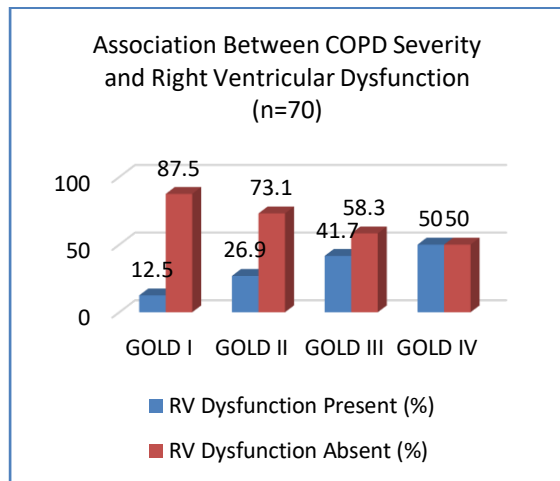


Figure 3 Association Between COPD Severity and Right Ventricular Dysfunction (n=70)

Serum CA125 levels were significantly higher among patients with right ventricular dysfunction compared with those without RV dysfunction. The mean CA125 level was 48.6 ± 18.9 U/mL in patients with RV dysfunction compared with 24.8 ± 10.6 U/mL in patients with preserved RV function ($p < 0.001$).

A significant positive correlation was observed between serum CA125 levels and PASP ($r = 0.62$, $p < 0.001$), whereas CA125 showed a negative correlation with TAPSE ($r = -0.54$, $p < 0.001$).

The association of CA125 with RV dysfunction is presented in Table 6.

Table 6: Association of Serum CA125 Levels with Right Ventricular Dysfunction

Parameter	RV Dysfunction Present (n=24)	RV Dysfunction Absent (n=46)	p-value
Serum CA125 (U/mL)	48.6 ± 18.9	24.8 ± 10.6	<0.001
CA125 >35 U/mL	18 (75.0%)	10 (21.7%)	<0.001
Correlation with PASP	$r = 0.62$		<0.001
Correlation with TAPSE	$r = -0.54$		<0.001

Discussion

Chronic obstructive pulmonary disease (COPD) is a systemic disorder associated with significant cardiopulmonary interactions. Apart from progressive airflow limitation, chronic hypoxia, pulmonary vascular remodeling, and increased pulmonary vascular resistance contribute to cardiovascular complications, particularly right ventricular (RV) remodeling and dysfunction. The present study evaluated RV dysfunction among 70 COPD patients using echocardiographic parameters and assessed its association with disease severity and serum CA125 levels. In the present study, the mean age of participants was 61.8 ± 8.6 years, with a male predominance (82.9%) and a high prevalence of smoking history (88.6%). Similar demographic patterns have been reported in previous studies, where COPD-related cardiac complications were predominantly observed among elderly male patients with significant tobacco exposure. Nasir et al. [11] also reported a higher prevalence of right ventricular abnormalities among COPD patients and emphasized the importance of cardiac evaluation in this population. Right ventricular dysfunction was identified in 24 (34.3%) patients in the present study, indicating that RV involvement is a common cardiovascular manifestation of COPD. The prevalence of RV dysfunction varies among studies depending on disease severity, diagnostic criteria, and echocardiographic parameters used. Das et al. [12] demonstrated that parameters such as tricuspid annular plane systolic excursion (TAPSE), right ventricular fractional area change (RVFAC), right ventricular myocardial performance index (RIMP), and pulmonary artery systolic pressure are valuable markers for detecting RV impairment in COPD patients. In the present study, patients with RV dysfunction showed significantly impaired systolic function compared with those having preserved RV function. TAPSE was significantly lower among patients with RV dysfunction (15.2 ± 2.1 mm vs 19.8 ± 2.9 mm; $p < 0.001$). TAPSE is a widely accepted marker of longitudinal RV contraction and provides a simple and reproducible assessment of RV systolic performance. Previous studies have demonstrated reduced TAPSE values among COPD patients, supporting the presence of early subclinical RV dysfunction. Similarly, RVFAC was significantly reduced in patients with RV dysfunction ($29.8 \pm 5.6\%$ vs $39.8 \pm 6.2\%$; $p < 0.001$). RVFAC reflects global RV systolic function and has been recognized as an important echocardiographic parameter for identifying RV impairment. Das et al. [12] reported that RVFAC and RIMP provide additional information regarding RV performance and may improve assessment beyond conventional parameters. Pulmonary artery systolic pressure (PASP) was significantly elevated among patients with RV dysfunction (55.6 ± 10.8 mmHg vs 31.6 ± 7.5 mmHg; $p < 0.001$). Increased PASP reflects elevated RV afterload secondary to chronic hypoxia

and pulmonary vascular remodeling. Hilde et al. [13] demonstrated that COPD patients may develop RV structural and functional abnormalities even with mild elevations in pulmonary artery pressure, indicating that RV involvement may occur early during disease progression. A significant association was observed between COPD severity and RV dysfunction in the present study. RV dysfunction was present in 50.0% of GOLD stage IV, 41.7% of GOLD stage III, and 12.5% of GOLD stage I patients ($p=0.032$). This finding indicates that progressive airflow limitation is associated with increased cardiovascular involvement. Advanced COPD causes persistent hypoxemia, increased pulmonary vascular resistance, and chronic RV pressure overload, leading to progressive impairment of RV function. Similar associations between COPD severity, pulmonary hypertension, and RV dysfunction have been reported in previous studies. The present study also demonstrated a significant relationship between serum CA125 levels and RV dysfunction. Patients with RV dysfunction had significantly higher CA125 levels compared with those without RV impairment (48.6 ± 18.9 U/mL vs 24.8 ± 10.6 U/mL; $p<0.001$). CA125 showed a positive correlation with PASP ($r=0.62$; $p<0.001$) and a negative correlation with TAPSE ($r=-0.54$; $p<0.001$). Although traditionally considered a tumor marker, CA125 has been increasingly recognized as a marker of cardiovascular stress, systemic congestion, and elevated venous pressure. Its association with RV dysfunction suggests a potential role as an adjunctive biomarker for identifying cardiopulmonary involvement in COPD.

The clinical importance of detecting RV dysfunction in COPD lies in its association with adverse outcomes. Armentaro et al. [14] demonstrated that right heart abnormalities may be present even in patients with mild COPD and are associated with increased cardiovascular risk. Therefore, routine echocardiographic assessment may facilitate early recognition of high-risk patients and allow timely intervention. Overall, the present study demonstrated that approximately one-third of COPD patients had evidence of RV dysfunction, which was associated with advanced disease severity, elevated pulmonary artery pressure, impaired RV systolic parameters, and increased serum CA125 levels. These findings highlight the importance of echocardiographic evaluation for early detection of cardiovascular involvement and improved prognostic assessment in COPD patients.

Conclusion

The present study demonstrated that right ventricular dysfunction is a frequent cardiovascular complication among patients with chronic

obstructive pulmonary disease and is associated with increasing disease severity. Echocardiographic parameters such as TAPSE, RVFAC, S' velocity, and pulmonary artery systolic pressure were useful for early identification of RV impairment. Right ventricular dysfunction was associated with higher pulmonary pressures and elevated serum CA125 levels, suggesting increased cardiopulmonary stress. Routine echocardiographic evaluation in COPD patients may help in early risk stratification, prognostic assessment, and timely management of cardiovascular complications.

Limitations

The present study was conducted with a relatively small sample size of 70 patients and was performed at a single center, which may limit the generalizability of the findings. The cross-sectional design prevented assessment of long-term changes in right ventricular function and clinical outcomes. Advanced imaging modalities such as cardiac magnetic resonance imaging and invasive hemodynamic assessment were not performed for validation of echocardiographic findings. Further multicentric studies with larger populations and longitudinal follow-up are required to confirm these observations.

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