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ORIGINAL ARTICLE

Diagnostic Performance of CT Pulmonary Angiography in Predicting COPD-Associated Pulmonary Hypertension

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ABSTRACT

Background: Pulmonary hypertension (PH) secondary to chronic obstructive pulmonary disease (COPD) is a common complication that requires early detection for better patient outcomes. Computed tomography pulmonary angiography (CTPA) offers comprehensive assessment of the pulmonary vessels and cardiac chambers in patients with suspected PH. This study aimed to evaluate the diagnostic performance of CTPA in predicting COPD-associated PH and to identify optimal CTPA parameters for its diagnosis.

Methods: This cross-sectional study included 30 COPD patients who underwent CTPA. The following measurements were recorded: main pulmonary artery (MPA) diameter, right and left PA diameters, MPA/ascending aorta diameters ratio, segmental PA/accompanying bronchus ratio, right ventricular (RV) lumen diameter, left ventricular (LV) lumen diameter, RV lumen/LV lumen ratio, RV wall thickness, and RV outflow tract thickness. According to transthoracic echocardiography (TTE) findings (reference standard), patients were classified into those with PH and without PH. Diagnostic performance of CTPA was evaluated using a 2x2 contingency table to estimate its accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Receiver operating characteristic (ROC) curve analysis with calculation of the area under the curve (AUC) was performed for each CTPA parameter.

Results: CTPA showed 80% accuracy, 85% sensitivity, 70% specificity, 85% PPV, and 70% NPV (p=0.002) in predicting COPD-associated PH. MPA diameter was the optimal parameter to predict PH, demonstrating the highest AUC = 1 at cut-off value of ≥ 28.7 mm.

Conclusions:CTPA showed good diagnostic performance in predicting COPD-associated PH, with MPA diameter being the optimal parameter.

Keywords: COPD; Pulmonary Hypertension; CTPA; TTE

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a progressive lung disease, associated with significant morbidity and mortality worldwide [1]. Pulmonary changes in COPD include airway narrowing, inflammation, and remodeling with alveolar destruction, leading to chronic bronchitis and emphysema [2,3].

Pulmonary hypertension (PH) is a common, but serious complication of COPD, affecting greater than 50% of patients with advanced COPD [4]. COPD-associated PH occurs secondary to chronic hypoxia, which causes pulmonary vascular remodeling [3,5]. According to the European Society of Cardiology (ESC)/European Respiratory Society (ERS) guidelines, PH is defined as a mean pulmonary arterial pressure (PAP) exceeding 20 mmHg at rest, as measured by right heart catheterization (RHC) [6].

COPD-associated PH progresses gradually and frequently presents with mild to moderate severity. However, it can significantly impact patients' clinical course and survival [4,7]. COPD patients' survival is inversely related to the severity of PH [4]. Thus, early diagnosis of COPD-associated PH is crucial for effective management [4].

Diagnosing COPD-associated PH can be challenging due to overlapping symptoms with COPD, particularly in the early stage [4]. However, the presence of unexplained progressive dyspnea and peripheral edema may suggest the possibility of PH in COPD patients [8].

While RHC is the gold standard for diagnosing COPD-associated PH, its invasive nature limits its routine use [4]. Non-invasive imaging modalities such as transthoracic echocardiography (TTE) and computed tomography pulmonary angiography (CTPA), offer valuable alternatives [9]. ESC/ERS guidelines recommend transthoracic echocardiography (TTE) as the initial imaging method for suspected PH [6]. However, employing TTE can be challenging in COPD patients, as it may be difficult to obtain clear images of cardiac chambers and tricuspid regurgitation jet due to chest hyperinflation [10].

CTPA offers comprehensive assessment of pulmonary vessels and cardiac chambers in patients with suspected PH [11]. So far, research exploring the predictive value of CTPA for PH in COPD patients is limited. Therefore, this study aimed to evaluate the performance of CTPA in predicting COPD-associated PH and to identify the optimal CTPA parameters.

METHODS

Study design and population

This cross-sectional study was approved by Zagazig University Institutional Review Board (IRB) (ZU-IRB#10822, approved on May 31, 2023), and was conducted in accordance with the ethical principles of the World Medical Association Helsinki Declaration. Informed written consent was obtained from each participant.

Between June 2023 and December 2023, 33 COPD patients with clinical suspicion or diagnosis of PH underwent CTPA at theRadiology Department in Zagazig University Hospitals. Patients were eligible for inclusion if they had (1) a CTPA of optimal quality and (2) complete medical records. Three patients were excluded due to (1) inadequate CTPA image quality (n=1) and (2) unavailable medical records (n=2).

Additionally, referred patients with contraindications to CTPA, such as a known allergy to contrast media, severe renal dysfunction, or pregnancy were not eligible for CTPA.

The following clinical data of the included patients were recorded by reviewing their medical reports: age, sex, history of smoking, clinical manifestations of lung disease, co-morbidites, and imaging findings of TTE.

Protocol of CTPA

All patients underwent non-ECG gated CTPA using a 16-multidetector CT scanner (Canon medical system incorporation, Aquilion prime, Japan). Prior to CTPA scan, all patients were instructed to fast from 6 to 8 hours and renal function tests were performed. The patients were scanned in a supine position and were instructed to remain stable and hold their breath at full inspiration during the scan. Axial images were acquired withcoronal and sagittal reformations.

Technical parameters of the employed CTPA protocol were as follows: scan range, from the apex of both lungs to the upper abdomen (liver dome); slice thickness, 1mm; slice interval, 1mm; Kvp,120; MAs, 140; pitch=1; field of view=350 mm; matrix size 512 x 512; and window settings, lung (level, −600 HU; width, 1600 HU) and mediastinal (level, 50 HU; width, 350 HU) windows.

Initially, a non-contrast CT chest scan was obtained. Then, the contrast agent (1-2 ml/kg of Omnipaque 350 mg Iodine/l; Iohexol, GE Healthcare, Ireland) was injected followed by saline (50 ml) using a dual injectorthrough the right antecubital vein. CTPA images were acquired by employing bolus tracking technique. A region of interest was positioned over the main pulmonary artery (MPA), then, image acquisition begun when a threshold contrast density was reached (120 HU).

CTPA images analysis

All CTPA scans were reviewed by a single radiologist (with 3 years of experience in radiology) using the PACS system (Paxera Ultima). The following measurements were derived from the axial mediastinal CTPA images: (1) MPA diameter; measured as its widest axial diameter at the level of its bifurcation [11],(2) right and left pulmonary arteries (RPA and LPA) diameters; assessed as their widest axial diameters at 1.5 cm from the MPA bifurcation [12], (3) MPA/AO ratio; by dividing MPA diameter to the ascending aorta (AO) diameter measured at the same axial level [13], (4) segmental PA/accompanying bronchus ratio; assessed by dividing segmental PA axial diameter to that of the adjacent bronchus [14], (5) Right ventricle (RV) lumen transverse diameter;assessed by measuring the maximal distance between the RV free wall and the interventricular septum at the mid-ventricular level [11], (6) Left ventricle (LV) lumen transverse diameter; assessed by measuring the maximal distance between the LV free wall and the interventricular septum at the mid-ventricular level [15], (7) RV lumen/LV lumen ratio; determined by dividing RV lumen transverse diameter to LV lumen transverse diameter, (8) RV free wall thicknessmeasured at the mid-ventricle level, (9) RV outflow tract (RVOT) thickness measured 1 cm below the pulmonary valve [16].

Reference standard

Based on TTE imaging findings, patients were classified into two groups: patients with PH and without PH.

Statistical analysis

Data were analyzed using IBM SPSS Statistics version 23.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including frequencies and percentages for categorical variables, and means with standard deviations for continuous variables, were calculated. The student's t-test was used to compare continuous variables.

To assess the agreement between CTPA and TTE in diagnosing PH, Kappa statistics were calculated. The diagnostic performance of CTPA in predicting PH was evaluated using a 2x2 contingency table to estimate its accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Receiver operating characteristic (ROC) curve analysis was conducted, calculating the area under the curve (AUC) to determine the optimal cut-off values for CTPA parameters. Statistical significance was set at $p \leq 0.05$.

RESULTS

Clinical characteristics of the study patients.

A total of 30 COPD patients (12 males and 18 females) were included in the study. Patients' age ranged from 45 to 85 years with a mean age (± SD) of 64.5 ± 11.7 years. Most patients had a history of smoking, with 13.3% being current smokers and 43.3% ex-smokers. Cough was the most common symptom, reported in all patients, followed by dyspnea in 93.3% of the patients. Hypertension was the most prevalent comorbidity, present in 63.3% of the patients. Detailed clinical characteristics of the patients are presented in Table 1.

Diagnostic performance of CTPA in predicting COPD-associated PH

CTPA accurately identified PH in 17 of 20 patients (85%) diagnosed with PH by TTE and correctly excluded PH in 7 of 10 patients (70%) without PH as determined by TTE. There was moderate agreement between CTPA and TEE in the diagnosis of PH, with kappa score= 0.55 (p=0.003)(Supplementary table 1).

CTPA detected PH with 80% accuracy, 85% sensitivity, 70% specificity, 85% PPV, and 70% NPV (p=0.002)(Table 2).

CTPA measurable parameters

Among all patients, the estimated mean MPA, RPA, and LPA diameters were 30 mm, 24.5 mm and 23.8 mm, respectively. The mean MPA/AO ratio was 0.88 and mean segmental PA/accompanying bronchus ratio was 1.52. The estimated mean RV and LV lumen transverse diameters and the mean RV lumen/LV lumen ratio were 40.8 mm, 37 mm, and 1.13, respectively. Mean RV wall thickness was 5.83 mm, while mean RV wall outflow tract thickness was 5.86 mm (Supplementary table 2).

Among patients without PH as determined by TTE (n=10), the estimated mean MPA, RPA and LPA diameters were 26 mm, 22.5 mm and 22.2 mm, respectively. The mean MPA/AO ratio was 0.77 and mean segmental PA/ accompanying bronchus ratio was 1.3. The estimated mean RV and LV lumen transverse diameters and the mean RV lumen/LV lumen ratio were 38.4 mm, 37 mm, and 1.1, respectively. Mean RV wall thickness was 4.6 mm, while mean RV wall outflow tract thickness was 3.8 mm (Supplementary table 2).

Among patients diagnosed with PH by TTE (n=20), the estimated mean MPA, RPA and LPA diameters were 32 mm, 22.6 mm, and

24.5mm, respectively. The mean PA/AO ratio was 0.94 and the mean segmental PA/ accompanying bronchus ratio was 1.64. The estimated mean RV and LV lumen transverse diameters and the mean RV lumen/LV lumen ratio were 42 mm, 37 mm, and 1.2, respectively. Mean RV wall thickness was 6.4 mm, while mean RV wall outflow tract thickness was 6.9 mm (Supplementary table 2).

Patients diagnosed with PH by TTE had significantly higher mean values for MPA diameter, PA/AO ratio, segmental PA/accompanying bronchus ratio, and RVOT thickness (p=0.004, 0.012, 0.033, <0.0001, respectively) than those without PH (Supplementary table2).

Also, patients diagnosed with PH had higher mean values of LPA diameter, RV lumen diameter, RV free wall thickness than those without PH but there was no significant difference (p=0.088, 0.433, 0.060, respectively) (Supplementary table 2).

Whereas no significant differences were observed in the mean values of the RPA diameter, LV lumen diameter, RV lumen/LV lumen ratio between the two patients' groups (p=0.939, 0.999, 0.227, respectively) (Supplementary table 2).

Diagnostic performance of the individual CTPA parameters.

As shown in Table 3, the optimal parameter to predict COPD-associated PH was MPA diameter demonstrating AUC=1, with high accuracy, sensitivity, specificity, PPV, and NPV of 100% for each, using a cut-off value of ≥ 28.7 mm (Figure 1).

Using RPA diameter cut-off value of ≥ 24 mm showed an AUC of 0.933, with sensitivity of 80%, specificity of 90%, PPV of 94%, NPV of 70 %, and accuracy of 83.3%.There was good performance of LPA diameter using cut-off value of ≥ 22 mm, which showed a sensitivity of 95%, specificity of 70%, PPV of 86%, NPV of 87.5%, and accuracy of 86.7% with an AUC of 0.823 (Table 3, Figure 1).

Furthermore, MPA/AO ratio showed good diagnostic performance using a cut-off value of ≥ 0.8, an AUC of 0.948, high sensitivity, specificity of 90% for each, PPV of 95%, NPV of 82% and accuracy of 90%.Segmental PA/accompanying bronchus ratio cut-off value of ≥ 1.3 demonstrated an AUC of 0.938, with sensitivity of 85%, specificity of 90%, PPV of 94%, NPV of 75%, and accuracy of 86.7% (Table 3, Figure 1).

Using RV transverse lumen diameter cut-off value of ≥ 50 mm in our study showed an AUC=0.768, with sensitivity of 50%, specificity of 100%, PPV of 100%, NPV of 50%, and accuracy 66.6%. Whereas using the left ventricular transverse lumen diameter cut-off value of ≥ 30 mm revealed an AUC=0.592, with sensitivity of 90%, specificity of 50%, PPV of 78%, NPV of 71%, and accuracy 76.7% (Table 3, Figure 2).

RV/LV lumen diameter ratio cut-off value of ≥1.14 revealed an AUC of 0.610, a sensitivity of 55%, specificity of 90%, PPV of 92%, NPV of 50%, and accuracy of 66.7%.Employing RV free wall thickness cut-off value of ≥ 4 mm in our study, yielded an AUC=0.838, with 85% sensitivity, 70% specificity, 85% PPV, 70% NPV and 80% accuracy.Using a cut off value of ≥ 4.5 mm of the RV outflow thickness showed an AUC=0.855, a sensitivity of 90%, specificity of 80%, PPV of 90%, NPV of 80%, and accuracy of 86.7% (Table 3, Figure 2).

Illustrative cases are presented in Figures 3 and 4.

*Table 1:**Clinical characteristics of the study patients.***

Clinical characteristics	
Age (years)	
-Mean ± SD	64.5 ± 11.17
-Range	45-85
Sex (n, %)	
-Male	18 (60%)
-Female	12 (40%)
Smoking status (n, %)	
-Non-smoker	13 (43.3%)
-Current smoker	4 (13.3%)
-Ex-smoker	13 (43.3%)
Clinical manifestations (n, %)	30 (100%)
-Cough	28 (93.3%)
-Dyspnea	13 (43.3%)
-Lower limb swelling	11 (36.7%)
-Fever	6 (20%)
-Chest pain	6 (20%)
-Wheezes	4 (13.3%)
-Cyanosis	1 (3.3%)
-Body ache	1 (3.3%)
-Hemoptysis	
Comorbidities (n, %)	
-No comorbidity	5 (16.7%)
-Hypertension	19 (63.3%)
-Diabetes	11 (36.7%)
-Atrial fibrillation	4 (13.3%)
-Obstructive sleep apnea	4 (13.3%)
-Hepatitis C	3 (10%)
-Bronchial asthma	2 (6.7%)
-Ischemic heart disease	2 (6.7%)
-Heart failure	1 (3.3%)
-Cancer thyroid	1 (3.3%)
-Arrhythmia	1 (3.3%)
-Bilharziasis	1 (3.3%)

Table 2: Diagnostic performance of CTPA in predicting PH.

CTPA	TP	FP	TN	FN	Accuracy	Sensitivity	Specificity	PPV	NPV	P-value
	17	3	7	3	80%	85%	70%	85%	70%	0.002

TP= true positive, FP= false positive, TN= true negative, FN= false negative, PPV= positive predictive value; NPV= negative predictive value. A p-value ≤ 0.05 is significant.

Table 3: Performance of CTPA parameters in the diagnosis of PH.

CTPA parameters	Cut-off value	AUC	Sensitivity	Specificity	PPV	NPV	Accuracy	P-value
MPA diameter (mm)	≥ 28.7	1.0	100%	100%	100%	100%	100%	< 0.001
RPA diameter (mm)	≥ 24	0.933	80%	90%	94%	70%	83.3%	< 0.001
LPA diameter (mm)	≥ 22	0.823	95%	70%	86%	87.5%	86.7%	0.002
MPA/AO ratio (mm)	≥ 0.8	0.948	90%	90%	95%	82%	90%	< 0.001
Segmental PA/ accompanying bronchus ratio	≥ 1.3	0.938	85%	90%	94%	75%	86.7%	< 0.001
RV lumen transverse diameter (mm)	≥ 50	0.768	50%	100%	100%	50%	66.6%	0.003
LV lumen transverse diameter (mm)	≥ 30	0.592	90%	50%	78%	71%	76.7%	0.501
RV lumen/LV lumen ratio	≥ 1.14	0.610	55%	90%	92%	50%	66.7%%	0.298
RV wall thickness (mm)	≥ 4	0.838	85%	70%	85%	70%	80%	< 0.001
RVoutflow tract thickness (mm)	≥ 4.5	0.855	90%	80%	90%	80%	86.7%	< 0.001

AO= ascending aorta; AUC= area under curve; MPA= main pulmonary artery; NPV= negative predictive value; LPA=left pulmonary artery; LV = left ventricle; PA= pulmonary artery; PPV= positive predictive value; RPA=right pulmonary artery; RV= right ventricle. A p-value ≤ 0.05 is significant.

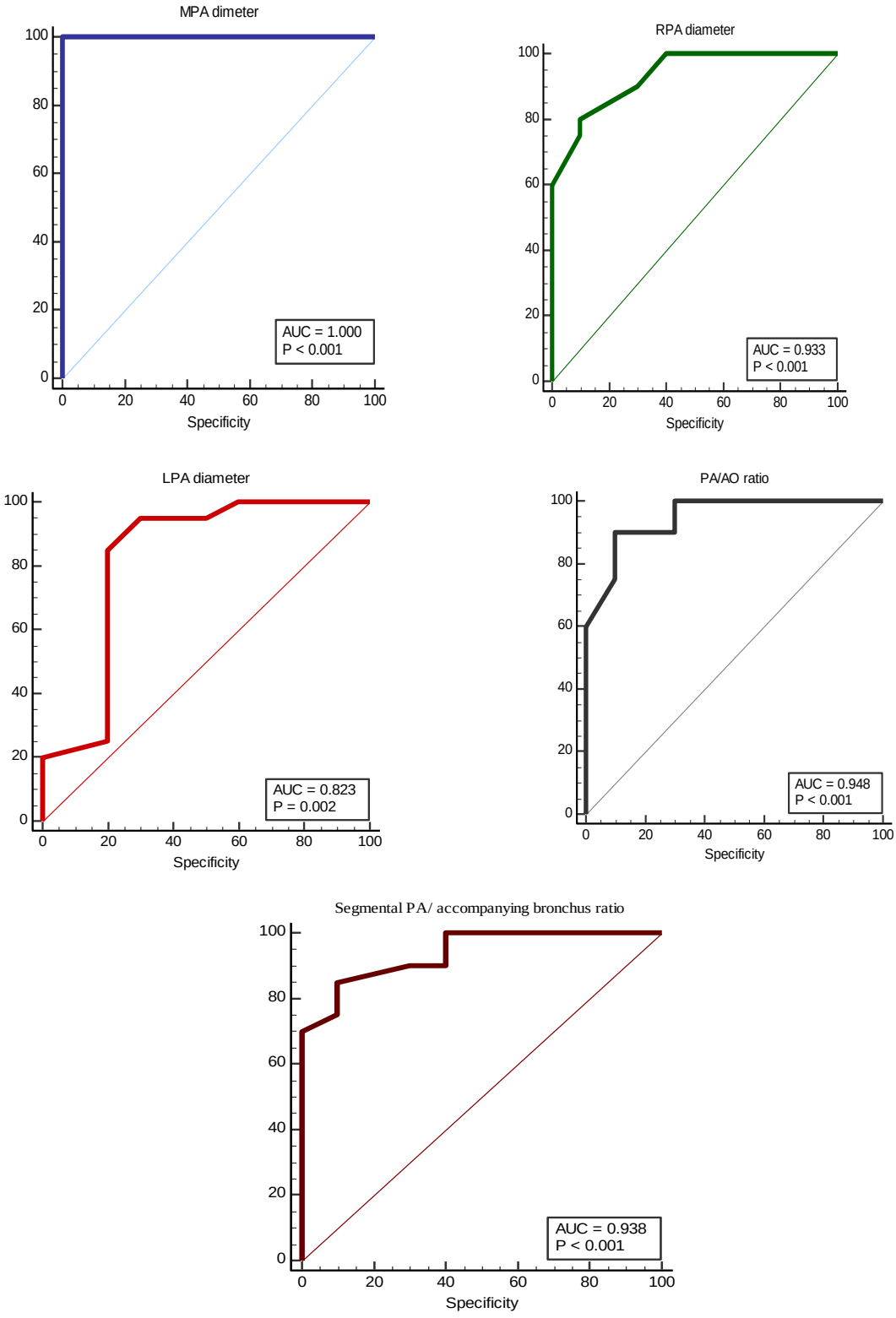

Figure 1: ROC curves of MPA, RPA, LPA diameters and PA/AO ratio and segmental PA/accompanying bronchus ratios in diagnosis of PH among study patients with estimated AUC of 1, 0.9333, 0.823, 0.948 and 0.938, respectively.

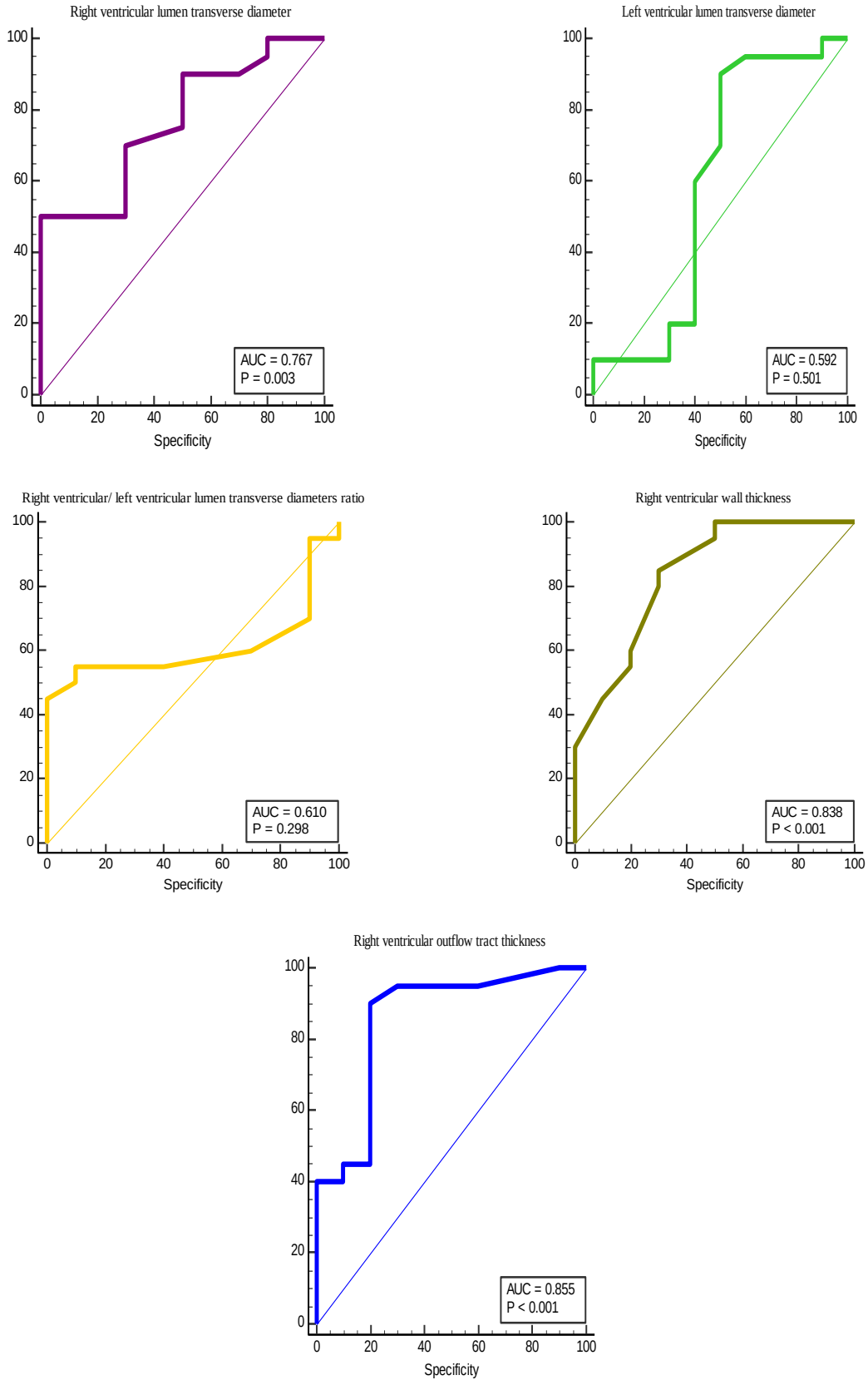

Figure 2: ROC curves of right and LV lumen transverse diameters, RV lumen/ LV lumen ratio, RV wall thickness, and RV outflow tract thickness in diagnosis of PH among study patients with estimated AUC of 0.767, 0.592, 0.610, 0.838 and 0.855, respectively.

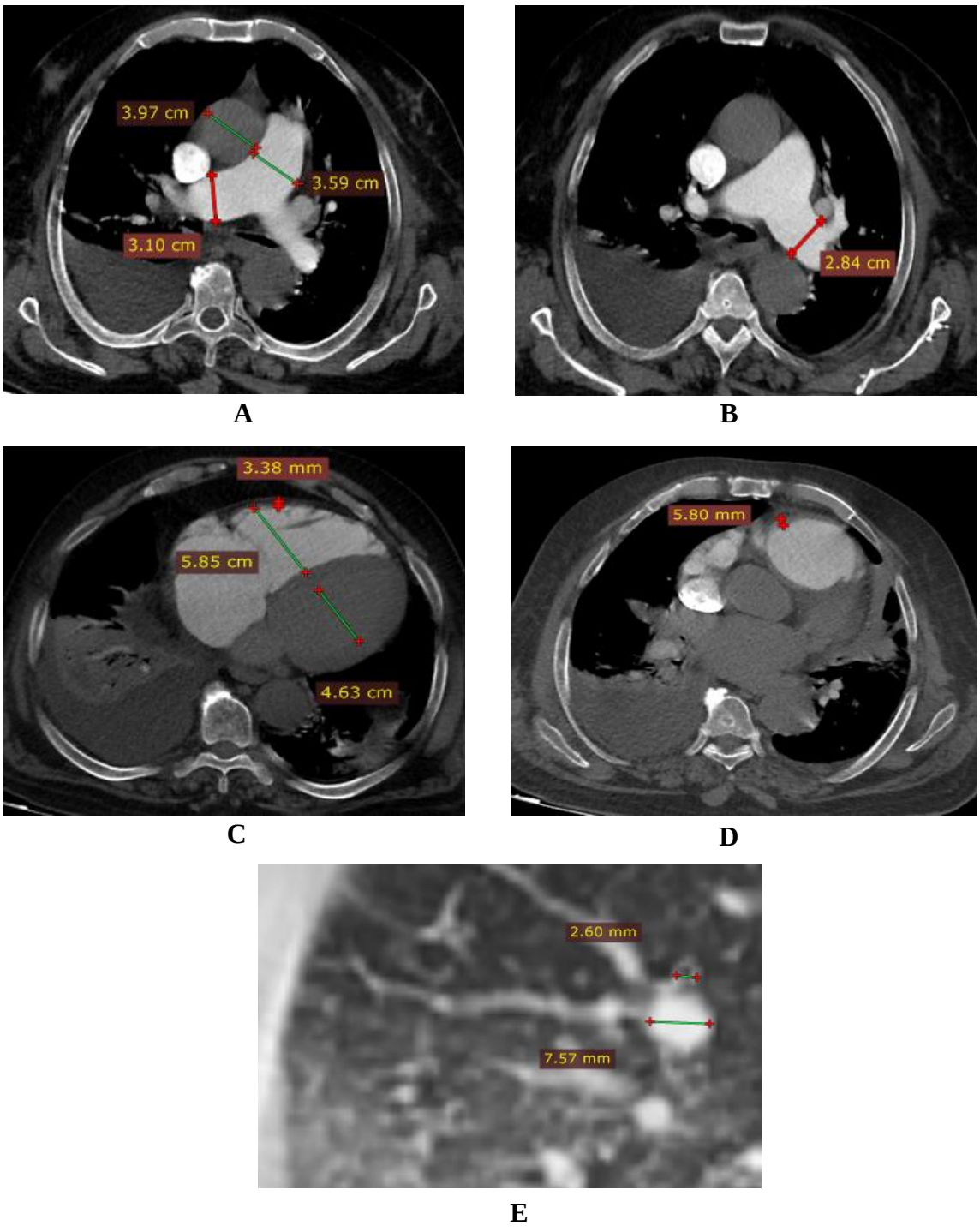

Figure 3: An 80-year-old male patient with COPD, a smoker, presented with cough, shortness of breath, raised body temperature, and LL swelling. The patient was diagnosed with PH by TTE. CTPA imaging findings were also suggestive of PH.
(A & B) axial CTPA images (mediastinal windows) at the level of the pulmonary trunk bifurcation showing dilated MPA measuring 36 mm in diameter, with MPA/AO ratio = 0.9. The RPA and LPA diameters measure 31 mm and 28.4 mm, respectively.
(C & D) axial CTPA images (mediastinal windows) at the cardiac level demonstrate enlarged RA and RV, with RV transverse diameter of 58.5 mm, measured at mid-ventricular level. The LV transverse diameter measures 46 mm, with RV/LV transverse diameters ratio = 1.3. Normal RV free wall thickness, measuring 3.4 mm with thickened RVOT, measuring 5.8 mm in thickness.
(E) axial CTPA images (lung window) exhibit increased segmental PA branch/ accompanying bronchus ratio = 2.9.

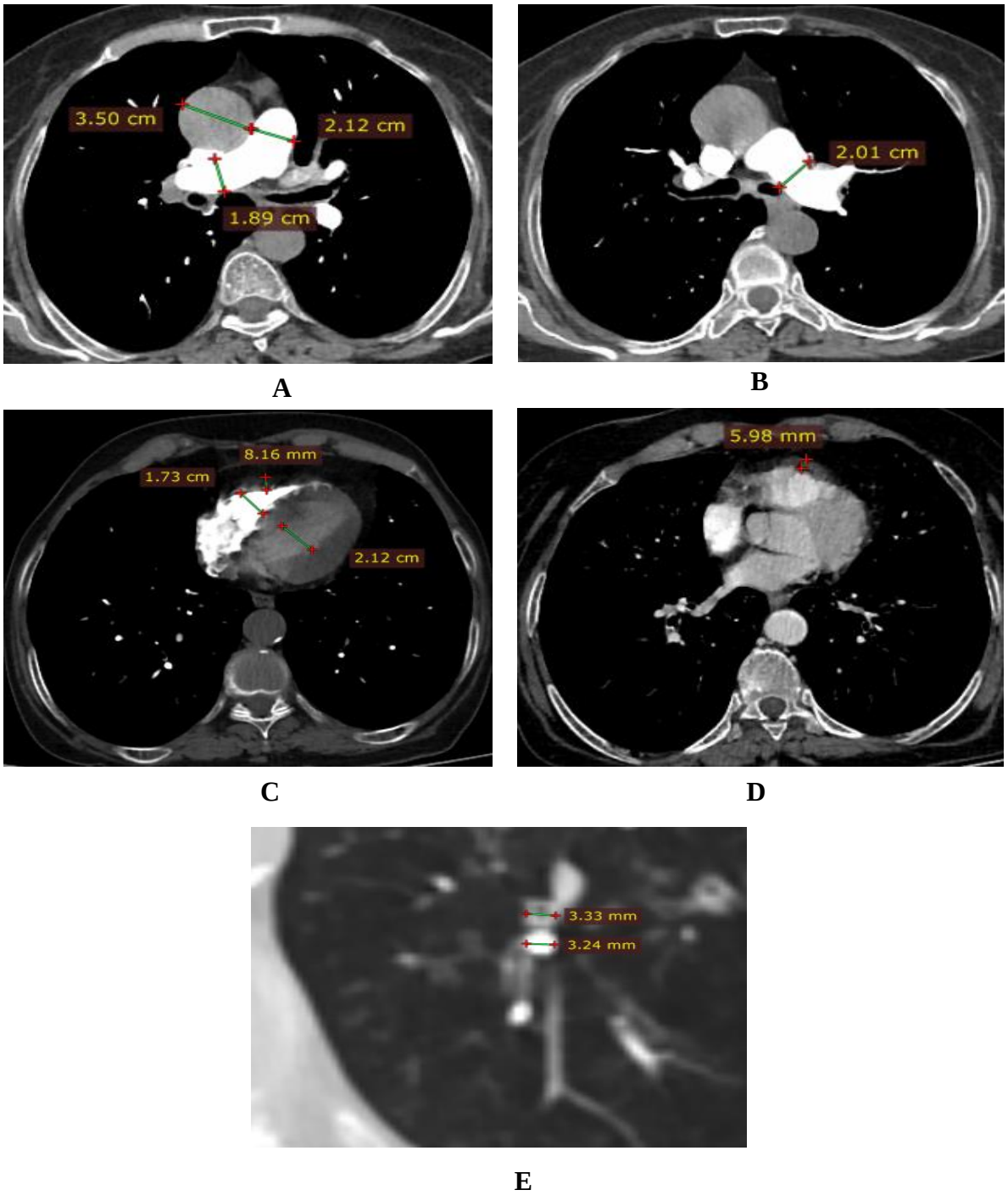

Figure 4: An 80-year-old female patient with COPD, a non-smoker, presented with cough, dyspnea and LL swelling. The patient was diagnosed with PH by TTE. However, CTPA imaging findings revealed no evidence of PH.
(A & B) axial CTPA image (mediastinal window) at the level of the pulmonary trunk bifurcation showing normal MPA diameter, measuring 21 mm, with normal MPA/AO ratio= 0.6. The RPA and LPA diameters measure 19 mm and 20 mm, respectively.
(C & D) axial CTPA images (mediastinal window) at the cardiac level demonstrate normal RV size, with RV transverse diameter of 17 mm, measured at mid-ventricular level. The LV transverse diameter measures 21 mm, with RV/LV transverse diameters ratio = 0.8. Increased RV free wall thickness, measuring 8 mm with increased RVOT, measuring 6 mm in thickness.
(E) axial CTPA images (lung window) exhibit normal segmental PA branch/ accompanying bronchus ratio = 0.96.

DISCUSSION

This study was conducted to evaluate the diagnostic performance of CTPA in the predicting COPD-associated PH and to identify optimal parameters for this diagnosis. The study included 30 COPD patients with a mean age of 64.5 ± 11.17 years.The age distribution of the study patients is in accordance with Chen et al. [17], whose study involved patients with a mean age of 69 ± 10 years.

The study population predominantly included females (60%). Conversely, Chen et al. [17] reported a higher proportion of male patients (79.2%). Hypertension was the most prevalent comorbidity among our patients, aligning with the observations of Iyer et al. [18] who reported hypertension as the most common comorbidity among their study population.

Compared to TTE, CTPA accurately detected PH in 85% of patients diagnosed with PH by TTE. Moderate agreement between CTPA and TTE in the diagnosis of PH was observed (kappa value = 0.55, p=0.003). CTPA showed good diagnostic performance in diagnosing PH with 80% accuracy, 85% sensitivity, 70% specificity, 85% PPV, and 70% NPV (P=0.002). This finding is consistent with Osman et al. [19], who reported comparable accuracy (72.2%), sensitivity (77.3%), specificity (64.3%), PPV (77.27%), and NPV (64.29%) for CTPA in predicting PH.

It is recommended to assess great vessels' diameters and both ventricles' dimensions on CTPA to diagnose PH [20]. Given potential anatomical variations in the MPA, calculating the MPA/AO ratio may reduce this effect [17]. Chronic pressure overload associated with PH induces adverse cardiac remodelling, primarily affecting the RV. Common RV changes include enlargement, increased wall thickness exceeding 5 mm, and a RV/LV lumen diameter ratio greater than 1 [21].

Various CTPA parameters, well-established for assessing pulmonary hypertension (PH) in the literature [15,22], were employed in our study. Consistent with Chen et al. (17), our findings demonstrated significantly higher mean MPA diameters in patients with PH compared to those without PH. In contrast, Swift et al. [22]demonstrated that RPA and LPA diameters in patients with PH were significantly higher than those with no PH.

Consistent with previous studies by Chen et al. [17] and Swift et al. [22], our findings demonstrated significant differences in mean MPA/AO ratio between patients with and without PH. In addition, our findings align with Elgazzar et al. [23], who observed a significant difference in the segmental PA/accompanying bronchus ratio between patients with and without PH.

Similar to Swift et al. [22], we demonstrated that patients with PH had higher mean RV lumen transverse diameter than those without PH. However, our resultscontrast with those of Liu et al. [24], who reported that patients without PH had higher mean LV lumen transverse diameter than those with PH. Furthermore, our results differ from those of Swift et al. [22] and Spruijt et al. [20], who reported significant differences among patients with and without PH regarding the mean RV lumen/LV lumen ratio.

Our results are also inconsistent with Liu et al. [24], who reported significant differences in the mean RV free wall thickness betweenpatients with and without PH. These discrepancies between our study and prior research [20,22,24] may be due to variations in the clinical characteristics of the studied patient populations. Conversely, our findings

agree with Swift et al. [22], who observed significant differences in the mean RVOT thickness among patients with PH and with no PH.

Among the evaluated CTPA parameters, MPA diameter emerged as the optimal predictor of PH, demonstrating perfect diagnostic performance (AUC=1, with 100% accuracy, sensitivity, specificity, PPV, and NPV), with a cut-off value of ≥ 28.7 mm. In contrast to our findings, Melzig et al. [12] reported a MPA diameter cut-off value of >29 mm with lower sensitivity, specificity, positive and NPV of 79%, 89%, 92% and 73%, respectively. Additionally, our results differ from Chen et al. (17), who revealed that RPA diameter was the optimal parameter to diagnose PH. The discrepancies in findings between our study and those of Melzig et al. [12] and Chen et al. [17] could be primarily attributed to the utilization of different cut-off values for CTPA parameters.

In this study, MPA/AO ratio was considered the second optimal parameter to diagnose PH after MPA diameter. Using MPA/AO ratio cut-off value of ≥ 0.8 showed an AUC of 0.948, high sensitivity, specificity of 90% for each, PPV of 95%, NPV of 82% and accuracy of 90%. These findings oppose Chen et al. [17], who reported lower performance of MPA/AO ratio using a cut-off value of ≥ 1, with an AUC of 0.641. The difference observed may be due to the employment of different cut-off values for the MPA/AO ratio.

According to our study, segmental PA/accompanying bronchus ratio was the third optimal parameter to diagnose PH. Employing a cut-off value of ≥ 1.3, segmental PA/accompanying bronchus ratio exhibited an AUC of 0.938, with sensitivity of 85%, specificity of 90%, PPV of 94%, NPV of 75%, and accuracy of 86.7%. Our results endorse the findings of Elgazzar et al. [23], who reported that combining MPA diameter >29 mm with segmental PA/accompanying bronchus ratio >1 showed good diagnostic performance for diagnosing PH (sensitivity of 72%, specificity of 100%, PPV of 100%, and NPV of 41.7%).

Finally, this study results suggest that CTPA, with its various parameters, can be effectively integrated into the diagnostic pathway of PH in COPD patients. This approach can help accurate diagnosis of PH in clinical practice, potentially leading to improved patients' outcomes.

Limitations

This study had some limitations. First, the study included a small number of patients and was performed at a single institution. Second, the reproducibility of the CTPA parameters was not evaluated, as a single radiologist reviewed all CTPA studies and evaluated all the parameters. Third, the use of TTE as the reference of standard, rather than the gold standard RHC, due to its invasive nature. However, research has shown a high correlation between CTPA and TTE in diagnosis of PH[25].

Conclusions

CTPA showed good diagnostic performance in the diagnosis of COPD-associated PH. Assessment of the CTPA parameters can be valuable for PH diagnosis, specifically MPA diameter, MPA/AO ratio, and segmental PA/accompanying bronchus ratio.

Conflict of interest

The authors declared that they have no conflicts of interest with respect to authorship and/or publication of this article.

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