Evaluation of platelet distribution width in chronic obstructive pulmonary disease patients with pulmonary embolism

Background: Platelets play an important role in the pathogenesis of pulmonary embolism (PE). We aimed to investigate whether there is a correlation between platelet distribution width (PDW) and chronic obstructive pulmonary disease (COPD) patients with PE. **Methods:** We conducted a retrospective study using 126 COPD patients with PE and 51 COPD patients without PE. Blood biomarkers, including PDW and D-dimer, were included. Odds ratios (OR) associated with PDW and interactions with D-dimer, SpO₂ were estimated for PE. **Results:** PDW was higher in the COPD patients with PE group ($p = 0.007$). A higher PDW had a significantly increased risk of PE than a lower PDW (adjusted OR 2.724, 95% CI: 1.290–5.753). **Conclusion:** PDW are elevated in COPD patients with PE and are associated with the risk of PE.

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Keywords: chronic obstructive pulmonary disease • platelet distribution width • pulmonary embolism

Pulmonary embolism (PE) is a common and sometimes deadly disease, with a wide variety of presenting symptoms, ranging from no symptoms at all to shock or sudden death [1,2]. Clinical diagnostic and evaluation testing is necessary before starting anticoagulation, which is the mainstay treatment for management of PE [3]. The management of patients with suspected PE has greatly improved in recent years because of clinical evaluation of the probability of PE via ultrasonography, ventilation perfusion scanning and spiral computed tomography pulmonary angiography (CTPA) [4]. But, the clinical diagnosis of PE in patients with chronic obstructive pulmonary disease (COPD) is often difficult due to the similarity in the presenting symptoms of the two conditions. PE resembles COPD so closely that the two are often impossible to distinguish clinically. Furthermore, PE is known to increase the death rate in COPD patients [5–7]. Thus, the remarkable resemblance in the clinical

symptoms of PE and COPD poses a clinical challenge. Clinical evaluation of PE and noninvasive tests to rule out the diagnosis in patients with COPD is particularly difficult, and has not yet been clearly recommended to these patients.

There have already been some reports that have evaluated PE in COPD patients. Incidence of PE in COPD patients has been reported to range from 28 to 51% [8,9], but some studies have reported the true frequency of PE in COPD patients in whom PE is clinically suspected ranges from 19 to 29% [10,11]. Lesser evaluated the characteristics of 108 COPD patients with suspected PE, and 21 (19%) received diagnoses of PE through pulmonary angiography [10]. In this population of COPD patients, risk factors, symptoms and arterial blood gas values were similar in patients with and without PE. Another report has shown that the presence of COPD does not affect the diagnostic performance of D-dimer testing, CTPA, or

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pulmonary angiography for PE [11]. Hence, there is a need for an easily accessible, cost-effective, and noninvasive method of clinical evaluation to determine the probability of PE in patients with COPD.

Platelets play an important role in the pathogenesis of PE [12]. For the indirect measurements of morphological parameters of platelets, parameters such as mean platelet volume (MPV), platelet distribution width (PDW) and platelet counts are suggested by many studies [13–17]. PDW is the relative width of the distribution of platelets in volume index of the heterogeneity of platelets. MPV and PDW, which are simple platelet markers, increase during platelet activation (PA) [12–14]. However, a few studies have examined the relationship between PDW and PE [18,19], yet, to the best of our knowledge, none of them studied the relationship between PDW and COPD patients with PE. Therefore, in this study, we retrospectively evaluated COPD patients with PE and examined factors associated with the presence of PE, with the aim to investigate whether there is a correlation between PDW and COPD patients with PE.

Methods

Ethics statement

Ethical approval for this study was granted from the Affiliated Dongyang Hospital of Wenzhou Medical University Human Investigation Ethics Committee (Dongyang, China) and all patients provided oral informed consent for enrollment into the study.

Subjects & sample collection

Data was retrospectively collected between January 2012 and May 2015 from Affiliated Dongyang Hospital of Wenzhou Medical University. The patients were divided into two groups based on the results of their CTPA: a COPD with PE group ($n = 126$) and a COPD without PE group ($n = 51$). A control group with normal airway flow were not recruited because with regard to PDW, no statistically significant differences were observed between patients with COPD and the control group [14]. According to the criteria set forth by the Global Initiative for Chronic Obstructive Lung Disease [20], the diagnosis of COPD for these patients was made based on available spirometric data and medical records. PE diagnosis was defined according to the European Society of Cardiology Guidelines [1]. The diagnosis of PE was confirmed by an identified filling defect in the pulmonary artery system in a CTPA of the chest or positive venous ultrasound of an extremity consistent with deep venous thrombosis (DVT) in patients with typical symptoms of PE (chest pain or dyspnoea). In addition, a positive D-dimer or scintigraphic ventilation perfusion (V/Q) scan read

was identified, supporting a high probability for PE, as recommended in the current guidelines. We collected all data regarding clinical symptoms and signs of the patients at the time of their hospital admission. The patients' accompanying disorders and risk factors on the same day as the CTPA exam and PDW were noted. Radiological examinations, including posteroanterior chest radiographs, CT and echocardiographic examination, were all performed within 6 h of admission. Five milliliters of blood were sampled for testing in the medical technology laboratory in the hospital. Blood was incubated at room temperature for 30 min, and centrifuged at 1500 g for 10 min to separate serum and blood cells. Serum was used for measuring the biochemical biomarkers indicated within 6 h. Another whole blood sample was used for cell counting performed within 2 h after blood sampling. Laboratory data included acute-phase reactants such as white blood cell count, C-reactive protein, arterial blood gas analysis, N-terminal-pro-B-type natriuretic peptide (NT-proBNP), D-dimer and blood biomarkers were also reviewed.

Computed tomographic pulmonary angiography

The thoracic CT scans were performed using a 64-detector multislice CT scanner (Brilliance 64-slice; PHILIPS, Amsterdam, The Netherlands) with an intravenously injected contrast agent while the patients held their breath. For multidetector scans, 100 ml of contrast was injected at 4 mm/s and 1.25-mm images were obtained at 1.2-mm intervals using a pitch of 1.0:1.0. CTPA results were categorized as positive for pulmonary embolism if an intraluminal filling defect was seen within a pulmonary arterial vessel and were considered negative if no filling defect was observed. Scans were considered technically inadequate only if main or lobar pulmonary vessels were not visualized.

Laboratory testing

Blood cell count testing was performed by the automated hematology analyzer XE-2100 for clinical purposes during baseline hospitalization (Sysmex Analyzer, Kobe, Japan). Blood cell count metrics included: hematocrit, hemoglobin, red cell distribution width (RDW), mean corpuscular volume (MCV), red blood cell count (RBC), platelet (PLT) count, PDW, MPV and total white blood cell (WBC) count. The other biochemical measurements were performed using a chemical analyzer, the Hitachi 7600–120 (Automatic analyzer, Tokyo, Japan). NT-proBNP testing was performed by an automated electrochemiluminescence analyzer, the Modular Analytics Cobas 601 (Roche Diagnostics, Germany).

Variable	Total (n = 177)	Without PE (n = 51)	With PE (n = 126)	p-value
Age, years (mean $\pm$ SD)	74.7 $\pm$ 8.3	74.6 $\pm$ 8.1	74.8 $\pm$ 8.5	0.934
Gender:				0.840
– Male/female	123/54	36/15	87/39	
Dyspnea:				0.105
– Yes/no	165/12	50/1	115/11	
Tachypnea:				0.061
– Yes/no	167/10	51/1	116/9	
Hemoptysis:				0.135
– Yes/no	33/144	6/45	27/99	
Pleuritic pain:				0.437
– Yes/no	11/166	2/48	9/118	
Syncope:				0.932
– Yes/no	10/167	3/48	7/119	
Hypoxia:				0.055
– Yes/no	125/52	30/20	95/32	
Cough:				0.195
– Yes/no	170/7	51/0	119/7	
Fever:				0.299
– Yes/no	46/131	16/35	30/96	
Hypertension:				0.562
– Yes/no	67/110	21/30	46/80	
Atrial fibrillation:				0.799
– Yes/no	19/158	5/46	14/112	
Diabetes mellitus:				0.525
– Yes/no	13/164	5/46	8/118	
Cancer:				0.726
– Yes/no	10/167	2/49	8/118	
Alcohol consumption:				0.083
– Yes/no	56/121	21/30	35/91	
Smoking:				0.308
– Yes/no	90/87	29/22	61/65	

PE: Pulmonary embolism.

Statistical analysis

Results have been presented as mean $\pm$ standard deviation (SD) or median and interquartile range (IQR), depending on the distribution. Univariate comparisons of continuous variables were performed using a two-sample independent t-test for normally distributed data, or nonparametric Mann–Whitney U-test for non-normally distributed variables. For comparing categorical data, a χ^2 test or Fisher's exact test was performed. The participants were categorized into one of two subgroups depending on biomarkers mean or median. A multivariable logistic regression model was

used to calculate the crude and adjusted ORs and 95% CIs. Statistical tests were evaluated at the two-sided 0.05 significance level. All statistical calculations were performed using SPSS 17.0 for Windows.

Results

Characteristics of study population

The baseline characteristics of COPD patients with PE and without PE are shown in **Table 1**. A total of 126 patients were included in the COPD with PE group and 51 patients were included in the COPD without PE group, making a total of 177 subjects. The mean

Table 2. Hematological and biological data of patients with and without pulmonary embolism.

Parameters	Without PE (n = 51)	With PE (n = 126)	p-value
WBCs ($10^3/\mu\text{l}$)	8.7 ± 4.9	7.6 ± 3.5	0.098
% Neutrophils	74 ± 12	73 ± 12	0.287
% Lymphocytes	15 ± 9	17 ± 9	0.119
RBCs ($10^6/\mu\text{l}$)	4.25 ± 0.72	4.15 ± 0.65	0.346
Hemoglobin (g/l)	126.6 ± 19.3	123.2 ± 18.9	0.275
Hematocrit (%)	39 ± 6	38 ± 6	0.153
MCV (fl/cell)	94.0 ± 6.8	92.9 ± 6.4	0.321
RDW (%)	13.5 ± 1.0	14.1 ± 2.0	0.037
PLT ($10^3/\mu\text{l}$)	220 ± 104	198 ± 67	0.172
PDW (%)	12.3 ± 2.8	13.4 ± 2.6	0.007
MPV (fl/cell)	10.1 ± 1.4	10.8 ± 2.0	0.036
Glucose (mmol/l)	5.10 ± 1.01	5.68 ± 1.78	0.005
Urea (mmol/l)	6.75 ± 2.61	6.71 ± 3.00	0.940
Creatinine ($\mu\text{mol/l}$)	68 ± 20	75 ± 36	0.166
Albumin (g/l)	37.3 ± 7.0	35.5 ± 3.9	0.077
PH	7.402 ± 0.047	7.408 ± 0.049	0.439
PaO ₂ (mmHg)	85.7 ± 26.6	81.1 ± 25.9	0.293
PaCO ₂ (mmHg)	49.0 ± 13.5	48.0 ± 13.1	0.642
SpO ₂ (%)	94.4 ± 4.9	91.9 ± 6.4	0.017
Lactate (mmol/l)	1.69 ± 0.83	1.57 ± 0.88	0.415
LDH (U/l)	222 ± 62	208 ± 85	0.281
TC (mmol/l)	3.94 ± 0.91	3.87 ± 0.84	0.612
TG (mmol/l)	1.04 ± 0.43	1.02 ± 0.49	0.819
HDL-C (mmol/l)	1.18 ± 0.34	1.20 ± 0.38	0.747
LDL-C (mmol/l)	2.17 ± 0.77	2.06 ± 0.67	0.340
CRP (mg/l)	30.0 (7.4, 55.0)	39.6 (12.3, 58.0)	0.036
D-dimer (mg/ml)	0.91 (0.69, 2.38)	1.55 (0.77, 5.64)	0.008
NT-proBNP (pg/ml)	319 (155, 1663)	503 (181, 1835)	0.224

Values are mean $\pm$ standard deviation (SD) or median and interquartile range (IQR).
 CRP: C-reactive protein; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol; MCV: Mean corpuscular volume; MPV: Mean platelet volume; NT-proBNP: N-terminal pro-brain natriuretic peptide; PaCO₂: Arterial carbon dioxide tension;
 PaO₂: Arterial oxygen tension; PDW: Platelet distribution width; PE: Pulmonary embolism; PLT: Platelet; RBC: Red blood cell; RDW: Red cell distribution width; SpO₂: Pulse oxygen saturation; TC: Total-cholesterol; TG: Triglycerides; WBC: White blood cell.

age was 74.8 ± 8.5 years in the COPD with PE group and 74.6 ± 8.1 years in the COPD without PE group. No significant difference was observed between the COPD with PE and without PE groups with respect to age, gender, main clinical symptoms and risk factors (a significant difference being $p > 0.05$). Current smokers and drinkers were defined as subjects with a positive history of smoking and drinking, respectively.

Laboratory findings

There were no significant differences among groups with respect to WBC, neutrophils (%), lympho-

cytes (%), RBC, hemoglobin, hematocrit, MCV, PLT, Urea, creatinine, albumin, PH, PaCO₂, PaO₂, lactate, LDH, TC, TG, HDL-C, LDL-C and NT-proBNP. The mean PDW was $12.3 \pm 2.8\%$ in the COPD without PE group and $13.4 \pm 2.6\%$ in the COPD with PE group. PDW were significantly higher in the COPD with PE group compared with the without PE group ($p = 0.007$). The median (IQR) D-dimer was 0.91 (0.69, 2.38) in the COPD without PE group and 1.55 (0.77, 5.64) in the COPD with PE group. D-dimer was significantly higher in the COPD with PE group compared with the COPD without PE group ($p = 0.008$).

Table 3. Depending on biomarkers mean or median subgroup analysis in participants.					
Variable	Without PE (n = 51)		With PE (n = 126)		p-value
	n	(%)	n	(%)	
D-dimer (mg/ml):					0.002
<1.26	35	68.6	54	42.8	
>1.26	16	31.2	72	57.2	
RDW (%):					0.124
<13.9	32	62.7	63	50.0	
>13.9	19	37.3	63	50.0	
PDW (%):					0.019
<13.1	33	64.7	57	45.2	
>13.1	18	35.3	69	54.8	
Glucose (mmol/l):					0.308
<5.51	29	56.8	61	48.4	
>5.51	22	43.2	65	51.6	
CRP (mg/l):					0.075
<35.0	31	60.8	58	46.0	
>35.0	20	39.2	68	54.0	
MPV (fl/cell):					0.265
<10.6	29	56.8	60	47.6	
>10.6	22	43.2	66	52.4	
SpO ₂ (%):					0.001
<92.6	16	31.4	81	64.3	
>92.6	35	68.6	45	35.7	
CRP: C-reactive protein; MPV: Mean platelet volume; PDW: Platelet distribution width; PE: Pulmonary embolism; RDW: Red cell distribution width; SpO ₂ : Pulse oxygen saturation.					

CRP: C-reactive protein; MPV: Mean platelet volume; PDW: Platelet distribution width; PE: Pulmonary embolism; RDW: Red cell distribution width; SpO₂: Pulse oxygen saturation.

The COPD with PE group had significantly higher RDW, MPV, glucose, CRP and lower SpO₂ (%) than the COPD without PE group. Table 2 shows hematological and biochemical markers in COPD patients with PE and without PE.

Depending on biomarkers mean or median subgroup analysis in participants

Table 3 shows the biomarkers mean or median subgroup analysis of COPD patients with PE compared with patients without PE. According to the data distribution, the specific cutoff values depending on biomarker's mean or median for subgroup analysis in participants. We choose biomarker's mean as cutoff values if data are normally distributed, and choose biomarker's median as cutoff values if data are non-normally distributed. Higher D-dimer and PDW subjects dominated in patients with PE (57.2 and 54.8%). The percentage of higher SpO₂ level in COPD patients was lower in patients with PE than patients without PE (35.7 vs 68.6%, $p = 0.001$). But, there were no significant differences in distribution of RDW and MPV,

glucose and CRP between the two groups according to biomarkers mean or median subgroup analysis.

Clinical characteristics among patients according to PDW mean

All patients with COPD were divided into two groups according to PDW mean (group 1: PDW >13.1%, group 2: PDW <13.1%). The clinical characteristics of COPD according to PDW mean are shown in Table 4. There were no significant differences in distribution of clinical characteristics among patients with and without PE according to PDW mean.

Biomarkers among PE patients according to thrombus in main pulmonary arteries & other arterial branches

All patients with PE were divided into two groups according to bilateral thrombus in main pulmonary arteries and other arterial branches. The mean PDW was $14.0 \pm 2.5\%$ in bilateral thrombus in pulmonary arteries branches group and $12.9 \pm 2.5\%$ in unilateral thrombus in pulmonary arteries branches group.

Table 4. Demographic characteristics of study subjects according to platelet distribution width mean.			
Variable	PDW < 13.1%; n = 90	PDW > 13.1%; n = 87	p-value
Dyspnea:			0.591
– Yes/no	83/7	82/5	
Tachypnea:			0.169
– Yes/no	83/7	84/3	
Hemoptysis:			0.214
– Yes/no	20/70	13/74	
Pleuritic pain:			0.726
– Yes/no	5/84	6/82	
Syncope:			0.531
– Yes/no	4/86	6/81	
Hypoxia:			0.599
– Yes/no	65/25	60/27	
Cough:			0.272
– Yes/no	88/2	82/5	
Fever:			0.894
– Yes/no	23/67	23/64	
Hypertension:			0.741
– Yes/no	33/57	34/53	
Atrial fibrillation:			0.420
– Yes/no	8/82	11/76	
Diabetes mellitus:			0.725
– Yes/no	6/84	7/80	
Cancer:			1.000
– Yes/no	5/85	5/82	
Alcohol consumption:			0.622
– Yes/no	30/60	26/61	
Smoking:			0.710
– Yes/no	47/43	43/44	
PDW: Platelet distribution width.			

PDW was significantly higher in the bilateral thrombus in pulmonary arteries branches group compared with the unilateral thrombus in pulmonary arteries branches group ($p = 0.020$). There were no significant differences among thrombus in the main pulmonary arteries group with respect of RDW, PDW, MPV, glucose, SpO_2 (%), CRP and D-dimer (Table 5). According to PDW mean (group 1: PDW > 13.1%, group 2: PDW < 13.1%), Higher PDW was shown to significantly correlate with bilateral thrombus in pulmonary arteries branches (66.1 vs 45.7%, $p = 0.023$) (Table 6).

Risks of PE in logistic regression analysis

Additionally, after controlling for the demographic

covariates, high D-dimer was significantly associated with a 3.53 times higher risk of PE (adjusted OR 3.535, 95% CI: 1.583–7.099), and higher PDW had a significantly increased risk of PE than lower PDW (adjusted OR 2.724, 95% CI: 1.290–5.753). Compared with the lower SpO_2 (%), the adjusted OR of PE significantly decreased to 0.201 (95% CI: 0.094–0.429) for higher SpO_2 (%) (Table 7).

Discussion

In the present study, PDW was significantly higher in the COPD patients with PE as compared with the COPD patients without PE. In addition, higher PDW was shown to significantly correlate with bilateral thrombus

Table 5. Biomarkers among pulmonary embolism patients according to thrombus in main pulmonary arteries and other arterial branches.

Variable	Thrombus in bilateral main pulmonary arteries		p-value	Thrombus in bilateral arterial branches		p-value
	Yes	No		Yes	No	
RDW (%)	14.6 ± 2.6	14.0 ± 1.9	0.293	14.1 ± 2.1	14.1 ± 1.9	0.904
PDW (%)	13.6 ± 2.5	13.4 ± 2.6	0.769	14.0 ± 2.5	12.9 ± 2.5	0.020
MPV (fl/cell)	11.0 ± 2.2	10.8 ± 2.0	0.597	11.0 ± 2.3	10.6 ± 1.8	0.211
Glucose (mmol/l)	5.55 ± 1.35	5.70 ± 1.84	0.755	5.75 ± 1.91	5.62 ± 1.68	0.675
SpO ₂ (%)	91.9 ± 6.2	91.9 ± 6.4	0.983	92.5 ± 5.4	91.4 ± 7.1	0.335
CRP (mg/l)	46.4 (13.0, 70.1)	40.5 (11.8, 58.0)	0.703	42.4 (19.0, 57.3)	37.6 (10.8, 59.0)	0.778
D-dimer (mg/ml)	2.18 (0.80, 6.30)	1.44 (0.77, 5.58)	0.548	1.71 (0.72, 5.24)	1.55 (0.87, 6.11)	0.669

Values are mean ± standard deviation (SD) or median and interquartile range (IQR).
CRP: C-reactive protein; MPV: Mean platelet volume; PDW: Platelet distribution width; RDW: Red cell distribution width; SpO₂: Pulse oxygen saturation.

in pulmonary arteries branches. Furthermore, a higher PDW might be a significantly increased risk of PE than a lower PDW. Considering the contribution of risk factors to PE, higher PDW showed significant association with COPD plus PE with a 2.724-folds increase.

Recently some researchers have recommended that platelets play an important role in the pathogenesis of inflammation, thrombosis and atherogenesis by interacting with endothelium and leukocytes or releasing mediators [21,22]. PE is a clinical thrombus formation in main pulmonary arteries and other arterial branches. Platelets are involved in several links of the process of thrombus formation and development, and the changes in platelet parameters reflect the platelet activation. Among them, PDW reflects the range of variability in platelet size, and it has been suggested that a high PDW may be an indicator of prothrombotic status [23]. It has been shown that large platelets have a greater mass, and they are both metabolically and enzymatically more active than smaller platelets [24]. Investigators have consistently reported that PDW may be associated with pulmonary diseases and increased platelet activation in patients with PE [12,14,18]. In the literature, there are limited studies evaluating platelet indexes in patients with PE. Increased levels of MPV observed in patients after DVT and acute PE have been reported to be correlated with the severity of right ventricular dysfunction [25–27]. Recently, increasing levels of MPV were identified as a predictor for venous thrombo embolism (VTE) in particular, VTE of unprovoked origin and an independent predictor of early death in a cute PE [27]. In our study, we found that PDW and MPV levels were significantly higher in the COPD patients with PE than the PDW and MPV levels in the COPD patients without PE. The mechanism(s) of this outcome has not been

clearly explained. Gunay *et al.* [18] reported that the mean values of MPV, PDW and PLT were higher in PE groups than in controls. However, Hilal *et al.* [28] found that MPV did not correlate to the diagnosis of acute PE. So far, the association between PDW and COPD patients with PE is a relatively uninvestigated area. We evaluated the platelet reactivity by measuring PDW and MPV in COPD patients with PE, supporting for the role of platelet abnormalities contributing to the pathophysiology of VTE [16,26]. Our study suggests that a higher PDW may be a predictor of bilateral thrombus in pulmonary arteries branches in COPD patients. Similar results regarding the role of PDW as a predictor have shown that PDW as potential markers of platelet activation can be used in the determination of disease severity, length of hospital stay, and lead therapeutic options for PE patients [18].

The contribution of risk factors to PE was assessed by a multivariable logistic regression analysis. Our model was adjusted for RDW, PDW, MPV, glucose, SpO₂, CRP, D-dimer, three of which have been shown to predict PE independent of other various risk factors. High D-dimer had a significantly increased risk of PE than low D-dimer (adjusted OR 3.535, 95% CI:

Table 6. Depending on platelet distribution width mean subgroup analysis of thrombus in bilateral arteries branches.

Variable	No		Yes		p-value
	n	(%)	n	(%)	
PDW(%)					0.023
<13.1	38	54.3	19	33.9	
>13.1	32	45.7	37	66.1	

PDW: Platelet distribution width.

Table 7. Odds ratio of pulmonary embolism in logistic regression analysis.

Variable	Adjusted odds ratio	95% CI	p-value
D-dimer (mg/ml)			
<1.26	1.000	–	–
>1.26	3.535	1.583–7.099	0.002
PDW (%)			
<13.1	1.000	–	–
>13.1	2.724	1.290–5.753	0.009
SpO₂ (%)			
<92.6	1.000	–	–
>92.6	0.201	0.094–0.429	0.001

OR was adjusted for red cell distribution width, PDW, mean platelet volume, SpO₂, C-reactive protein and D-dimer.
PDW: Platelet distribution width; SpO₂: Pulse oxygen saturation.

1.583–7.099). Considering the contribution of risk factors to PE by PDW, it was significantly associated with a 2.724 times increased risk of PE (adjusted OR 2.724, 95% CI: 1.290–5.753). This indicates that early diagnosis of PE is crucial to at-risk patients, and doctors could evaluate at-risk patients according to PDW of COPD patients. Effective treatments are available to prevent or reverse many manifestations of disorders if the disease is discovered earlier. Our study may raise awareness for this potentially life-threatening disorder. We performed a detailed assessment of potential confounding factors that should make our results more generalizable; however, the possibility of residual confounding factors could not be entirely eliminated.

Our study had several limitations. First, the sample size was relatively small. Second, we conducted a retrospective study, and could not observe whether a relationship exists between elevated PDW and the morbidity of PE as many patients with acute PE died before admission and their medical records were absent. Thus, the collected medical records could not reflect the full scope of PE. We look forward to larger samplings and prospective studies.

Conclusion

We conducted a retrospective study on the evaluation of PDW in COPD patients with PE. Our findings suggest that PDW are elevated in COPD patients with PE, and the higher PDW may be associated with bilateral thrombus in pulmonary arteries branches in this group of patients. Doctors should focus on at-risk patients according to these risks of PE. As it stands, effective treatments are available that will prevent or reverse many manifestations of this disorder if it is discovered early. Further prospective studies are needed to clarify

and validate the predictive value of PDW, as well as measure novel cell-specific molecular markers of functional activity with outcomes in COPD patients.

Future perspective

The remarkable resemblance in the clinical symptoms of PE and COPD poses a clinical challenge. Clinical evaluation of PE and noninvasive tests to rule out the diagnosis in patients with COPD is particularly difficult. So, in the future, there is a need for an easily accessible, cost-effective, and noninvasive method of clinical evaluation to determine the probability of PE in patients with COPD. Although our results showed that PDW are elevated in PE patients with COPD and are associated with the risk of PE. Further prospective studies are needed to elucidate the putative pathophysiologic mechanisms explaining PDW's association with PE, to clarify and validate the predictive value of PDW levels, as well as measure novel cell-specific molecular markers of functional activity with outcomes in patients with COPD.

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Ethical conduct of research

The authors state that they have obtained appropriate institutional review board approval or have followed the principles outlined in the Declaration of Helsinki for all human or animal experimental investigations. In addition, for investigations involving human subjects, informed consent has been obtained from the participants involved.

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Executive summary

Background

- Platelets play an important role in the pathogenesis of PE. PDW is the relative width of the distribution of platelets in volume index of the heterogeneity of platelets.

Methods

- We conducted a retrospective study on the evaluation of PDW in COPD patients with/without PE.

Results

- In the present study, the PDW was significantly higher in the COPD patients with PE as compared to the COPD patients without PE.
- In addition, the PDW level was significantly higher in the group of patients with bilateral thrombus in pulmonary arteries branches compared with the group of patients with unilateral thrombus in pulmonary arteries branches.
- Furthermore, a higher PDW had a significantly increased risk of PE than a lower PDW.
- The contribution of risk factors to PE was assessed by a multivariable logistic regression analysis.
- Our model was adjusted for RDW, PDW, MPV, glucose, SpO₂, CRP, D-dimer, three of which have been shown to predict PE independent of other various risk factors.
- High D-dimer had a significantly increased risk of PE than low D-dimer (adjusted OR 3.5, 95% CI: 1.6–7.1).
- Considering the contribution of risk factors to PE by PDW, it was significantly associated with a 2.724 times increased risk of PE (adjusted OR 2.724, 95% CI: 1.290–5.753).

Discussion

- This indicates that early diagnosis of PE is crucial to at-risk patients, and doctors should evaluate at-risk patients according to these risks of PE.
- Effective treatments are available that will prevent or reverse many manifestations of this disorder if the disease is discovered early.
- Our study may raise awareness for this potentially life-threatening disorder.
- We performed a detailed assessment of potential confounding factors that should make our results more generalizable; however, the possibility of residual confounding factors could not be entirely eliminated.
- Our study had several limitations. First, the sample size was relatively small. Second, we conducted a retrospective study, and could not observe whether a relationship exists between elevated PDW and the morbidity of PE as many patients with acute PE died before admission and their medical records were absent.
- Thus, the collected medical records could not reflect the full scope of PE.
- We look forward to larger samplings and prospective studies.

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