Original Investigation

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Clinical Utility of Red Blood Cell Distribution Width Parameter in Patients with Hemodynamically Stable Acute Pulmonary Embolism

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Abstract

Objective: Patients with acute pulmonary embolism (PE) presenting with persistent hypotension or shock are considered to be high-risk, while hemodynamically stable patients with acute PE are classified as low- or moderate-risk, depending on their right ventricular dysfunction and/or levels of biomarkers indicating myocardial injury. In this study, we assessed the clinical benefits of knowing the red cell distribution width (RDW) parameter in patients with hemodynamically stable acute PE.

Methods: All patients diagnosed with acute PE in our hospital between 2008 and 2010 were retrospectively included in the study. Patients with hypotension, a history of malignancy, heart failure, and/or anemia were excluded. Patients with normotensive acute PE were divided into either a low- or moderate-risk group. This classification was made according to echocardiographic right ventricular dysfunction, positive troponin T, and the level of NT-proBNP. Red cell distribution width values of low and moderate acute PE risk groups were compared.

Results: Thirty-two patients were assessed as moderate-risk and 34 patients were low-risk PE. Red cell distribution width values of the moderate-risk group were significantly higher than those of the low-risk group (14.77±0.54 vs. 14.09±0.43; p=0.036, respectively).

Conclusion: Analysis of RDW values can help to determine the low and moderate risk levels of hemodynamically stable patients with acute PE.

Keywords: Acute pulmonary embolism, red blood cell distribution width, risk classification

INTRODUCTION

The determination of risk classification and course of treatment must be made at the same time in patients presenting with acute pulmonary embolism (PE). Further laboratory tests are not necessary in the treatment of hemodynamically unstable (shock or hypotension) PE patients, since this group is accepted as high-risk. However, further tests are necessary when planning the treatment of normotensive PE patients. Patients with low risk are often discharged in the early period, while PE patients with moderate risk are often hospitalized longer (1). Indicators of ventricular dysfunction and/or myocardial damage are sought for the risk classification of normotensive acute PE patients (1-5). Right ventricular dysfunction is usually evaluated by an echocardiographic examination and levels of natriuretic peptide, while myocardial damage is evaluated by measuring troponin levels (1). However, there are often difficulties in making the risk classification. Right ventricular functions may fail to be evaluated because of the poor echogenicity in persons with obesity and chronic lung disease, and biomarker levels may not be high at the time of admission (6,7). Red cell distribution width (RDW) is a quantitative indicator of the size variability of red blood cells. This parameter can be easily obtained from a full blood count and is accepted as an indicator of ineffective red cell production (8). Some studies have suggested that RDW may be associated with cardiovascular and pulmonary diseases (9-14). In this study, we aimed to investigate RDW values in patients presenting with hemodynamically stable acute PE.

METHODS

Patients diagnosed with acute PE in our hospital between 2008 and 2010 were retrospectively studied. Patients with hypotension, malignancy, history of heart failure, and/or anemia were excluded

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Table 1. Demographic and clinic features of pulmonary embolism patients

Age (years)	57±13
Male gender	33 (51.6%)
Diabetes mellitus	10 (15.6%)
Hypertension	27 (42.2%)
Smoking	12 (18.8%)
Systolic BP (mm Hg)	121±22
Diastolic BP (mm Hg)	76±12
Heart rate (pulse/minute)	91±19

Continuous variables were expressed as mean±standard deviation and categorical variables were expressed as number and percentage.
BP: blood pressure

Table 2. Characteristics of the patients with acute pulmonary embolism

	n	%
Presentation complaints		
Chest pain	34	53.1
Shortness of breathing	41	64.1
Coughing	14	21.9
Hemoptysis	10	15.8
Syncope	1	1.56
Predisposing factors		
History of deep vein thrombosis	11	17.2
Collagen tissue disease	3	4.7
Use of oral contraceptives	5	7.8
History of immobilization	27	42.2
History of previous surgery	18	28.1
Troponin T positivity	9	14.1
Right ventricular dysfunction		
NT-proBNP elevation	17	26.6
Echocardiographic	26	40.6

NT-proBNP: N-terminal pro B-type natriuretic peptide

from the study. The diagnosis of acute PE was confirmed with a multislice spiral computed tomography in all of the patients. Full blood count and measurements of troponin T and NT-pro BNP were carried out during admission, and records of transthoracic echocardiography, ordered within 24 hours, were used in this study. Patients having at least one of the criteria, which included echocardiographic right ventricular dysfunction and elevated NT-pro BNP or troponin T, were assigned to the moderate-risk PE group (1). Patients not having any of these criteria were included in the low-risk PE group (1). RDW measurements were obtained from an automatic full blood count device. The normal reference range of RDW was 11.7-14.3% in our laboratory. Anemia was defined as a hemoglobin value <13 g/dL in males and <12 g/dL in females (15). Levels of troponin T and NT-proBNP were measured from the same serum specimens (Roche Diagnostics GmBH-Germany). Troponin T >0.01 ng/mL and NT- pro BNP >1000 pg/mL were considered to be significant (16). Transthoracic echocardiography that was ordered within the first 24 hours was examined with a Philips Envisor C model echocardiography device and 3.2 mHz adult probe. On transthoracic evaluation, right ventricular dysfunction was accepted as tricuspid regurgitation jet velocity >2.6 m/sec, hypokinesis, or dilation in the right ventricular wall (right ventricular end-diastolic diameter/left ventricular end-diastolic diameter >1 in apical four-chamber) (4,17).

Statistical Analysis

Continuous data are expressed as mean ± standard deviation (SD), while categorical data are expressed as percentages. Differences in continuous data were analyzed with the student's t-test, and categorical data were compared with the chi-square test. A two-tailed p value <0.05 was considered to be statistically significant. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) statistical software package (Version 12: SPSS Inc., Chicago, IL, USA).

RESULTS

Ninety-seven patients were diagnosed with acute PE between 2008 and 2010 in our hospital. Thirty-three of these patients were excluded from the study due to hypotension (12), malignancy (12), heart failure (4), and anemia (5). The remaining 64 acute PE patients were included in the study. The most common presentation complaints in the acute PE group were shortness of breath (64%) and chest pain (53%), while 27 patients (42%) had immobilization, 18 (28%) had undergone surgery, 11 (17%) had deep-vein thrombosis, 5 (8%) used oral contraceptive drugs, and 3 patients (5%) had a history of collagen tissue disease (Table 1). There was elevated troponin T in 9 (14%) patients and elevated pro-BNP in 17 (%27) patients upon admission, while right ventricular overload was found in 26 (41%) patients on the echography performed within the first 24 hours. Based on the levels of troponin T and NT-proBNP and the echocardiographic findings, 32 patients were considered as having moderate risk and 34 were considered at low risk for PE (Table 2). RDW values were significantly higher in the moderate-risk group than in the low-risk group (14.77±0.54 vs. 14.09±0.43, p=0.036, respectively) (Table 3). Five patients were lost during the in-hospital follow-up (one of them was released with retroperitoneal hemorrhage after thrombolytic therapy). RDW values were significantly higher in PE patients who died in the hospital than in the survivors (15.56±0.82 vs. 14.32±0.43, p<0.049, respectively).

DISCUSSION

Pulmonary embolism is a relatively infrequent cardiovascular emergency that accounts for 0.4% of hospital presentations (18). The mortality rates of the disease differ according to the clinical condition. Therefore, it is important to make an appropriate risk classification in patients diagnosed with PE (19). Risk classification begins with hemodynamic examination and continues with laboratory testing. Hypotensive PE is a life-threatening emergency situation requiring specific treatment. Reperfusion therapy should be administered quickly in these patients, who often have high mortality (2,3). Treatment strategy in normotensive PE patients has been a controversial issue. An appropriate treatment should be initiated rather than waiting to see the patient's outcome, which may be hemodynamic impairment (20). The mortality rate is 2% in low-risk PE, while it can be as high as

Table 3. RDW values in the patients with low vs. moderate risk for pulmonary embolism

	Low risk PE (n=34)	Moderate risk PE (n=30)	P values
RDW (%)	14.09±0.43	14.77±0.54	0.036
Hg (g/dL)	13.30±1.10	13.36±1.17	0.164
PLT (x109/L)	297±126	295±88	0.424

Variables were expressed as mean±standard deviation.
Hg: hemoglobin; PLT: platelet; RDW: red cell distribution width

15% in patients with moderate-risk PE (19). Thrombolytic therapy is administered in normotensive PE patients with moderate risk (those not having increased risk for hemorrhage), while PE patients with low risk can be discharged early, provided they receive proper ambulatory care and anticoagulation therapy (1,21). It may be difficult to perform risk classification in normotensive PE patients. Right ventricular functions may fail to be evaluated because of poor echogenicity in persons with obesity and/or chronic lung disease, and biomarker levels may not be high in the early periods (6,7).

Red cell distribution width is a parameter that can easily be obtained from a simple full blood count in a short time. Recent studies have reported that RDW may be associated with cardiovascular and pulmonary diseases (9-14). RDW has been demonstrated to be a prognostic indicator in symptomatic heart failure patients (9). In later studies, elevated RDW has been reported to be an independent predictor of mortality and morbidity in patients with heart failure (22-25). It has been shown to be a stronger prognostic indicator than ejection fraction, functional capacity, renal Function, and pro-BNP (9). In a study investigating RDW elevation in coronary artery patients, it was shown that high RDW may be associated with cardiac death, non-fatal myocardial infarction, stroke, and new-onset heart failure (11,13). In another study with patients having pulmonary hypertension (due to any reason), high RDW correlated with increased pressure of the right atrium (12). In a study investigating the significance of RDW in acute PE patients, hemodynamic parameters were demonstrated to be worse in patients with elevated RDW. High RDW was found to have high sensitivity but low specificity for early mortality in PE patients (14). In this study, we found that RDW was higher in PE patients than in the controls. When patients with low and moderate risk were compared following the risk classification, moderate-risk patients had a higher RDW value. In addition, RDW values were observed as higher in patients who died in the hospital compared to those that did not. The cause of elevated RDW in cardiovascular and pulmonary diseases has not been clearly elucidated. It may be due to other concomitant diseases, malnutrition, inflammatory cytokines, and increased neurohormonal activation (9,10,12,26,27).

The main limitations of this study were that it was retrospective and that there was a small number of cases. Further prospective and extensive studies with a larger number of cases are needed.

CONCLUSION

Red cell distribution width is a parameter that can easily be obtained from a simple full blood count. High RDW at admission may be associated with an increased risk of mortality in acute PE patients. Such patients should be closely monitored for hemodynamic deterioration. Furthermore, RDW values may provide insight into early risk classification in patients with right ventricular functions that could not be evaluated due to echogenicity or in patients with negative biomarkers during admission.

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