

Prognostic value of platelet mass index in pulmonary emboli in the emergency department

The value of platelet mass index in pulmonary embolism

Hüseyin Uzunosmanoğlu, Şeref Kerem Çorbacıoğlu, Tuba Şafak, Seda Dağar, Emine Emektar, Yunsur Çevik
Department of Emergency Medicine, Kecioren Training and Research Hospital, Ankara, Turkey

Abstract

Aim: Pulmonary embolism is one of the common causes of pulmonary emergencies that are encountered frequently in the emergency department, the diagnosis of which can be extended or skipped. It is approximately one-third of the causes of death in the emergency room. A missed diagnosis increases mortality rates fivefold. Many scoring systems can be used in diagnosis but it may lead to prolonged stay in the emergency room and increase cost and mortality rate. This study primarily aims to evaluate PMI (Platelet mass index) in early diagnosis and mortality relationship in clinically compatible cases.

Materials and Methods: This retrospective study was conducted with patients diagnosed with pulmonary embolism in the emergency room between 01.01.2018 and 01.03.2020. From accessed data of all patients, vital signs, additional diseases, laboratory parameters, PESI scores, and one-month mortality rates were recorded with given thrombolytic treatments.

Results: One hundred forty patients, with available data were included in the analysis. Patients were classified according to mortality. In the mortal group, PMI value was 1.55 & 1.2 and lower, respectively, than the non-mortal group ($p: 0.031$). In addition, when compared with the non-mortal group, in the mortal group, lactate, troponin, D-Dimer and PESI score increase were statistically significant ($p < 0.001$).

Discussion: PMI value decreased in the mortal patient group. PMI can be useful in predicting the course of the disease and the risk of mortality in patients diagnosed with pulmonary embolism.

Keywords

Pulmonary embolism; Platelet mass index; PESI score

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Corresponding Author: Hüseyin Uzunosmanoğlu, Emergency Medicine Specialist, Kecioren Training and Research Hospital, Department of Emergency Medicine, Ankara, Turkey.

E-mail: huzunosmanoglu@gmail.com GSM: +90 5058908090 P: +90 312 356 90 00 F: +90 312 3569002

Corresponding Author ORCID ID: <https://orcid.org/0000-0002-4370-1283>

Introduction

Pulmonary thromboembolism (PE) remains the third leading cause of death with a high mortality rate in populations admitted to ED, despite advanced therapeutic options. If this disease is properly diagnosed and high-risk patients are determined in early stage, the high mortality rate can be decreased [1]. Therefore, risk stratification in the early-stage period gains importance in decreasing mortality rate. Although several clinical scores including pulmonary embolism severity index (PESI) have been developed to predict short-term prognosis [2-4], the majority of these scores are complicated and time-consuming tools. Therefore, in recent years, there has been a growing interest among physicians in simple blood markers that can be helpful in risk stratification [5,6].

Platelet mass index (PMI) is a member of the platelet indices and it is obtained by multiplication of platelet count (PC) with mean platelet volume (MPV) value ($PMI = PC \times MPV$). Since PMI includes PC and MPV values, PMI is considered to provide more comprehensive data on total platelet mass [7]. Several previous studies showed that increased total platelet mass and PMI related several diseases with thrombotic processes in its pathogenesis such as; ischemic stroke, myocardial infarcts, carotid artery stenosis, recurrent abortus, etc. [8-11]. Similarly, increased platelet indices were reported in PE patients in several studies [12-14]. However, the results of current studies on PMI in patients with PE are uncertain and controversial. Therefore, this study aimed to assess the prognostic utility of PMI values in predicting the 30-day-mortality in adult patients who presented to the ED and were diagnosed with PE.

Material and Methods

Study design

This retrospective prognostic study was conducted with PE patients in the Emergency Department of a training and research hospital between January 2018 and March 2020 after receiving approval from a local hospital ethics committee (No: KEAH-43278876-929- E1267).

Study population and data collection

This study screened electronic data and file records of all patients over 18 years of age who admitted to ED and were diagnosed with PTE by pulmonary computed tomography (CT) angiography. Patients who had acute exacerbations of chronic obstructive pulmonary disease, chronic inflammatory disease, hematological disease or pregnancy were excluded from this study because it is shown that platelet indices increase in these diseases [15-18].

The demographical and clinical characteristics of the patients, results of complete blood count (CBC) including PMI, D-Dimer values, length of hospitalization, PESI scores, and disposition types including mortality were extracted from the hospital electronic data system and patient file records by two independent researchers.

Measurement of platelet indices

For PMI measurement, 2 cc venous blood samples taken from all patients routinely at admission were used. Samples were collected in EDTA tubes and were processed at the laboratory of the emergency department within 2 hours by a Mindray BC 6800 hematology analyzer. The normal range of platelet indices

at our laboratory was as follows: platelet count (PC), $156-373 \times 10^3/\mu\text{L}$; mean platelet volume (MPV), 6.9–10.8 fL, platelet distribution width (PDW), 12-25; plateletcrit (PCT) 0-10%.

Statistical analysis

Statistical analyses were performed using SPSS 15.0 (Chicago, IL, USA). The categorical values of the patients were expressed as a number and a percentage and were analyzed with a chi-square test. The normality of the data distribution was determined with the Shapiro-Wilk test, histogram, and Q-Q plots. Continued values were presented as a mean standard deviation (SD) or median values and an interquartile range (IQR) of 25%–75%. The non-parametric values were analyzed using the Mann-Whitney U, and the parametric values were analyzed with the Student t-test. To assess the prognostic utility of PMI levels at varying cut-off values for the distinction between the survivor and non-survivor groups, a receiver-operating characteristic (ROC) curve was generated, and the area under the curve (AUC) was calculated. The 95% confidence intervals (95% CIs) were also calculated when appropriate, and a p-value of less than 0.05 was considered statistically significant.

Results

In the study period, 140 patients with diagnosed PE were included in the analyses. Among them, 52.1% (73) were males. The median age of the patients was 63.5 [IQR25%–75%; 54 to 87.9] years. The median value of the PESI score was 104 [IQR25-75%: 91.5 to 121]. The mortality rate was %18.6 (26 patients). All other demographics and the laboratory results of all patients are presented in Table 1.

When comparing survivor and non-survivor patients, PMI was found as 1.55 [IQR25-75%: 1.20 to 2.20] in the survivor group and 1.2 [IQR25-75%: 0.85 to 2] in the non-survivor group. Similarly, the median value of D-Dimer was found as 1310 [IQR25-75%: 840 to 2100] in survivor group and 4625 [IQR25-75%: 3000 to 5650] in the non-survivor group ($p < 0.001$). And finally, median values of the PESI score were found as 98 [IQR25-75%: 88 to 111] in the survivor group and 150.5 [IQR25-75%: 144 to 164] in the non-survivor group. These differences were statistically significant ($p < 0.03$, $p < 0.001$, and < 0.001 , respectively). All other data are presented in Table 2.

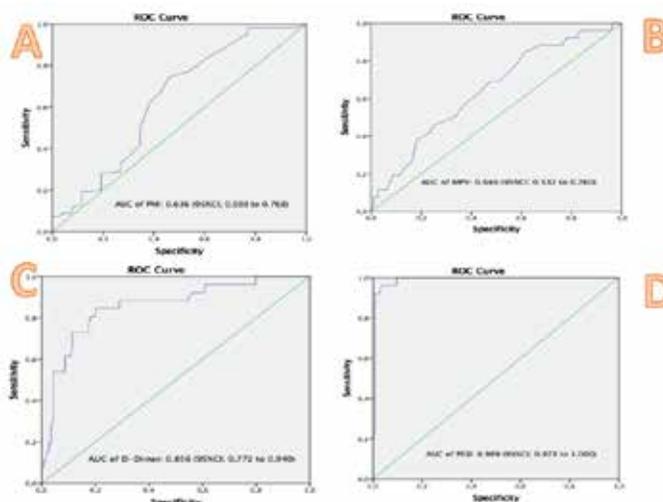


Figure 1. Area under curve (AUC) values of Platelet Mass index (A), Mean platelet volume (B), D-Dimer (C), and pulmonary embolism severity index (D) to prediction mortality.

ROC analysis was performed, and AUCs were calculated to discover the cut-off level for PMI, MPV, D-Dimer, and PESI score for distinguishing between the survivor and non-survivor groups. Accordingly, the AUC values were found to be 0.636 (95%CI; 0.503 to 0.768), 0.646 (95%CI; 0.532 to 0.760), 0.856 (95%CI; 0.772 to 0.940), and 0.989 (95%CI; 0.973 to 1.000) (Figure 1). In addition, when the correlation between the PMI and both variables (PESI score and D-Dimer) was evaluated, no statistically significant correlation was found (p=0.058 and p=0.6, respectively).

Table 1. Characteristics of the patients.

Variables	N= 140
Gender n (%)	
Male	73 (52.1)
Age median (IQR 25-75%)	63.5 (54 to 87.9)
Presence of comorbidities n (%)	122 (87.1)
Chronic hypertension	79 (56.4)
Diabetes mellitus	38 (27.1)
Coronary artery disease	58 (41.4)
Malignity	43 (30.7)
Congestive heart failure	33 (23.6)
COPD	45 (32.1)
Vital signs on admission median (IQR 25-75%)	
Temperature CO	37.2 (36.6 to 37.7)
Pulse rate beat/min	110 (102 to 118)
Oxygen saturation %	90 (88.25 to 92)
Systolic blood pressure mmHg	102 (90 to 124)
Diastolic blood pressure mmHg	65 (60 to 80)
PESI score median (IQR 25-75%)	104 (91.5 to 121)
PESI score stage (IQR 25-75%)	3 (3 to 4)
Laboratory findings on admission median (IQR 25-75%)	
pH	7.46 (7.37 to 7.51)
pCO2	31.9 (23.8 to 43)
Base excess	2.65 (-0.48 to 5.85)
Lactate	1.06 (0.81 to 1.64)
HCO3	22.9 (20.4 to 26.2)
Troponin	59 (44 to 86.75)
White blood cell	12.05 (7.7 to 16.4)
Neutrophil	9.13 (5.34 to 12.97)
Lymphocyte	1.44 (0.90 to 2.11)
Platelet	164.5 (118 to 232.5)
Mean platelet volume	9.4 (8.8 to 9.9)
Platelet mass index	1.5 (1.1 to 2.1)
Hemoglobin	11.4 (9.8 to 13.55)
Glucose	130 (97 to 186.7)
Urea	63.4 (38.5 to 87.52)
Creatine	1.28 (0.85 to 1.57)
GFR	76.05 (55.55 to 89)
Sodium	139 (134 to 141.75)
Potassium	3.9 (3.6 to 4.33)
D dimer	1655 (940 to 3155)
Mortality rate n (%)	26 (18.6)
Thrombolytic rate n (%)	58 (41.4)
Hospitalization time/day (IQR 25-75%)	7 (5 to 10)

Table 2. Demographical and clinical characteristics of patients according to the presence of survivor

Variables	Survivor n: 114	Non-survivor n: 26	P value
Gender n (%)			
Male	62 (54.4)	11 (42.3)	0.2
Age median (IQR 25-75%)	62 (52.75 to 78.25)	74.5 (58 to 90)	0.01
Presence of comorbidities n(%)	98 (86)	24 (92.3)	0.3
Chronic hypertension	68 (59.6)	11 (42.3)	0.1
Diabetes mellitus	28 (24.6)	10 (38.5)	0.1
Coronary artery disease	46 (40.4)	12 (46.2)	0.5
Malignancy	30 (26.3)	13 (50)	0.01
Congestive heart failure	13 (17.5)	20 (50)	<0.001
COPD	33 (28.9)	12 (46.2)	0.09
Vital signs on admission median (IQR 25-75%)			
Temperature	37.1 (36.5 to 37.6)	37.9 (37.35 to 38.45)	<0.001
Pulse rate	108 (99.5 to 115)	121 (116.75 to 127)	<0.001
Oxygen saturation %	91(89.75 to 92)	87 (86 to 89)	<0.001
Systolic blood pressure	110 (94.75 to 126.5)	90 (85 to 95)	<0.001
Diastolic blood pressure	68 (60 to 82.5)	58 (45 to 60)	<0.001
Laboratory findings on admission median (IQR 25-75%)			
pH	7.46 (7.39 to 7.50)	7.475 (7.18 to 7.55)	0.6
pCO2	32.2 (24.4 to 40.45)	30.8 (19.8 to 61.4)	0.9
Base excess	2.65 (0.17 to 5.75)	2.30 (-7.47 to 6.40)	0.2
Lactate	0.98 (0.79 to 1.26)	3.23 (1.36 to 4.50)	<0.001
HCO3	23.2 (20.8 to 26.1)	20.95 (16.6 to 28.17)	0.2
Troponin	55 (40.25 to 66)	119 (91.75 to 167.75)	<0.001
White blood cell	10.4 (7.70 to 15.25)	16.9 (10.9 to 19.62)	0.002
Neutrophil	7.83 (5.29 to 12.07)	13.56 (8.17 to 17.1)	0.001
Lymphocyte	1.51 (0.93 to 2.22)	1.23 (0.84 to 1.97)	0.285
Platelet	166 (126.25 to 245)	133 (92.25 to 202.59)	0.02
Mean platelet volume	9.30 (8.8 to 9.8)	9.65 (9.07 to 10.3)	0.02
Platelet mass index	1.55 (1.20 to 2.20)	1.2 (0.85 to 2)	0.03
Hemoglobin	11.4 (9.8 to 13.8)	11.5 (9.57 to 12.25)	0.2
Glucose	126.5 (96 to 176)	163.5 (104.25 to 217.25)	0.1
Urea	60 (35.1 to 75.1)	109.5 (76.7 to 169.3)	<0.001
Creatine	1.21 (0.8 to 1.40)	1.66 (1.30 to 2.11)	<0.001
GFR	77.95 (61.1 to 91)	43.3 (32.9 to 64.1)	<0.001
sodium	138 (134 to 141)	139.5 (133 to 143)	0.5
Potassium	3.91 (3.6 to 4.3)	3.82 (3.29 to 4.41)	0.7
D-dimer	1310 (840 to 2100)	4625 (3000 to 5650)	<0.001
PESI score median (IQR 25-75%)	98 (88 to 111)	150.5 (144 to 164)	<0.001
PESI score stage (IQR 25-75%)	3 (3 to 4)	5 (5 to 5)	<0.001
Thrombolytic rate n (%)	47 (41.2)	11 (42.3)	0.9
Length of Stay time/day (IQR 25-75%)	7 (5 to 9)	8 (3 to 14)	0.7

Discussion

The present study, which evaluated the prognostic value of PMI in detecting the mortality in patients who presented to ED and were diagnosed PE, revealed that PMI values are lower in non-survivor patients with PE diagnosis than survivor patients. However, when considered the low AUC value of PMI (0.636), it is difficult to say that this is a useful marker for predicting mortality in patients diagnosed with PE. In the current literature, several studies evaluated the relationship between platelet indices and venous thromboembolism, the

number of studies that evaluated the relationship between PMI and venous thromboembolism is limited.

In particular, the relationship between MPV and venous thromboembolism has been well-studied in previous studies. The main findings of these studies suggest that high MPV values are related to venous thromboembolism and its severity, and may be thrombus size. In a study that researched the relationship between MPV and venous thromboembolism, Icli et al have reported that MPV values were higher in all deep vein thrombosis (DVT) cases than healthy control subjects. In addition, they reported that MPV values were higher in cases with DVT accompanied by PE than in patients without PE [19]. When they performed ROC analysis to predict whether all DVT patients would have PE for MPV values, they found that the AUC value for MPV as 0.93. In another study, conducted with patients with PE, Yardan et al evaluated whether MPV values predict right ventricle (RV) dysfunction or not. They reported that MPV values were higher in PE patients with RV dysfunction than without RV dysfunction. In ROC analysis, to predict RV dysfunction for MPV, they reported that the AUC value of MPV was 0.671 (95% CI: 0.584 to 0.758) [6]. Other studies focused on the diagnosis of VTE in the literature have clearly reported that MPV values were related to VTE (DVT or PE) patients. However, at the same time, these studies' results suggest that MPV has no additional diagnostic contribution to D-Dimer for VTE diagnosis [12, 20-24]. Similar to previous studies, we found that increased MPV values were related to PE diagnosis and prognosis. However, considering low AUC values, we believe that the clinical use of MPV values in daily practice for prediction mortality is limited. In more recent years, as a member of the platelet indices, PMI is considered to provide more comprehensive data than MPV alone on total platelet mass. Therefore, recent studies have focused on PMI. However, there are several studies on different diseases such as ischemic stroke, myocardial infarcts, carotid artery stenosis, and recurrent abortus [8-11]; to the best of our knowledge, the number of studies that focused on the relationship between PMI and VTE is limited. In a study conducted with PE patients, Moharamzadeh et al studied PMI values and have reported that no statistically significant differences were found between PE patients and healthy control subjects [14]. In our study, we did not study the diagnostic performance of PMI. Therefore, we did not have control subjects. At the beginning of the study, given that PMI values with CBC examining are performed routinely, we planned to evaluate the prognostic performance of PMI values. Finally, we found that PMI values were lower in non-survivor patients than survivor patients. However, considering low AUC value of PMI for prediction mortality, we believe that clinical use of PMI is limited to distinction survivor and non-survivor patients.

Limitations

This study has some limitations. First, this study was conducted in a single center and it was retrospectively planned. In addition, the study population was relatively small. Therefore, the main findings of this study cannot be generalized to the general population.

Conclusion

In conclusion, this study showed that the PMI levels decreased in the non-survivor group of PE patients; it might be helpful

to distinguish between the survivor and non-survivor. However, considering the low AUC value of PMI and no correlation between PMI and PESI score, we believe that additional prognostic contribution is limited.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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