DOI: 10.5455/msm.2023.35.264-269
Received: Nov 20 2023; Accepted: Dec 15, 2023

ORIGINAL PAPER Mater Sociomed. 2023; 35(4): 264-269

Prothrombotic, Proinflammatory Markers, and Troponin in Type 2 Diabetes Mellitus Might Be a Predictive Factors for Pulmonary Embolism

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ABSTRACT

Background: The association between diabetes mellitus type 2 (T2DM) and pulmonary embolism (PE) is still unclear. **Objective:** The aim of this study was to determine the prognostic value of prothrombotic, proinflammatory markers, and troponin for pulmonary embolism and its complications in patients with type 2 diabetes mellitus. **Methods:** The retrospective cohort study included 294 patients with type 2 diabetes mellitus divided into two groups: (a) the first group with pulmonary embolism (n=165); (b) the control group without pulmonary embolism (n=129). The data were collected from May 2018 to May 2023. In all patients we analyzed: anthropometric parameters, laboratory parameters (troponin, D-dimer, CRP, fibrinogen, uric acid, glucose, total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides), arterial blood pressure, antiphospholipid antibodies, HOMA-IR index, CT angiography of the pulmonary artery, rate of adverse clinical events in pulmonary embolism (need for inotropic catecholamine support, fibrinolysis, cardiopulmonary resuscitation) and rate of intrahospital mortality from pulmonary embolism. **Results:** Troponin levels were significantly higher in the PE group compared to the non-PE group (p = 0.002). D-dimer, CRP, uric acid, fibrinogen and HOMA- IR were significantly elevated in the PE group compared to the non-PE group (p < 0.001). Patients with pulmonary embolism in T2DM proved to have significantly more in-hospital death within 10 days of hospital admission (p<0.001), compared to patients with T2DM, without pulmonary embolism. **Conclusion :** Prothrombotic, proinflammatory markers, and troponin have good prognostic value for short-term outcomes in PE among patients with T2DM.

Keywords: pulmonary embolism, type 2 diabetes mellitus, prothrombotic markers, proinflammatory markers, troponin

1. BACKGROUND

Type 2 diabetes mellitus (T2DM) is a prothrombotic, proinflammatory, and hypofibrinolitic state, but the association between diabetes mellitus and pulmonary embolism is still unclear (1). Globally, pulmonary embolism (PE) is the third leading vascular disease after myocardial infarction and stroke, with a high risk of adverse clinical outcomes (2). Although T2DM has been previously shown to be associated with a procoagulant and hypofibrinolytic state, current data exploring the role of T2DM in pulmonary embolism are limited (3). Several studies (4-6) have demonstrated that increased accumulation of adipose tissue and consecutive dysregulation of adipokine secretion precipitate a prothrombotic and proinflammatory state, resulting in vascular remodeling, atherosclerosis, and atherothrombosis, both systemically and locally. A significant percentage of patients who demonstrate an increased risk of pulmonary embolism in T2DM still remain unrecognized.

Type 2 diabetes mellitus with cardiovas-

cular complications represents one of the most frequent public health problems in Bosnia and Herzegovina. There is no major research of this type that could explain the relationship between pulmonary embolism and diabetes mellitus, and offer an optimal combination of biomarkers for diagnosis and risk stratification of pulmonary embolism in T2DM, adapted to our health system.

T2DM is a generalized thromboembolic disease. The key pathophysiological mechanisms of atherosclerosis and pulmonary embolism in diabetes mellitus are prothrombotic and proinflammatory state. The prothrombotic state is associated with an elevated level of fibrinogen, increased platelet aggregation, and atherogenic dyslipidemia. A proinflammatory state is associated with elevated CRP, uric acid, and hyperglycemia (7). Various diagnostic algorithms are constantly being tested globally and that will reduce the costs of pulmonary embolism diagnostics, which should become imperative in Bosnia and Herzegovina as well.

Type 2 diabetes mellitus promotes endothelial dysfunction and atherosclerosis. Therefore, the prothrombotic and proinflammatory markers of atherosclerosis may be used as predictors of pulmonary embolism and its complications in the T2DM. An improved understanding of the role that T2DM plays in pulmonary embolism could better inform clinicians on the most appropriate management of these patients, including the potential benefit of the initiation of adjuvant therapies aimed at the reduction of T2DM components (1).

Damage to the fibrinolytic system can be a primer for the development of atherothrombosis, because it leads to fibrin deposition and stimulates the proliferation and migration of vascular cells. Hypofibrinolysis may be an important factor predisposing to atherothrombosis in type 2 diabetes mellitus. The biological process of fibrinolysis is a great dynamic puzzle. Disorders of fibrinolysis have been described in metabolic syndrome, diabetes mellitus and obesity. Investigating fibrinolysis disorders in these conditions may be helpful in understanding the pathogenesis of atherothrombosis in these individuals (8). The mechanism of association between elevated D-dimer, fibrinogen, thrombosis, pulmonary embolism and T2DM has not yet been precisely defined. D-dimer has been shown to be the most useful marker of fibrinolysis and an indicator of procoagulant activity. The D-dimer is very sensitive in excluding the diagnosis of pulmonary embolism if normal values, low clinical suspicion, and nonconclusive diagnostic radiological lung scans are present (9).

The role of troponin in patients with acute pulmonary embolism has been widely investigated, but many questions remain open. Most authors agree that the role of troponin, similar to echocardiography, is primarily prognostic due to the low sensitivity and specificity in the diagnosis, but that elevated troponin values may indicate a group of patients with an increased risk of adverse outcomes. In previous studies, plasma troponin values significantly correlated with the severity of the disease, i.e., right ventricular dysfunction (10, 11). The basic approach to a patient with pulmonary embolism includes, in addition to a correct diagnosis, an accurate risk assessment that is the basis for further treatment.

This study is timely because there appears to be an emerging international interest in the association between type 2 diabetes mellitus and pulmonary embolism. Diabetes mellitus is a major public health problem in South-Eastern Europe and this is the first study conducted in Bosnia and Herzegovina in relation to this topic.

2. OBJECTIVE

The aim of this study was to determine the prognostic value of prothrombotic, proinflammatory markers, and troponin for pulmonary embolism and its complications in patients with type 2 diabetes mellitus. Similar studies have not been conducted in our region yet.

3. PATIENTS AND METHODS

Participants

This retrospective cohort study included 294 patients with type 2 diabetes mellitus, divided into two groups: (a) the first group with pulmonary embolism (n=165); (b) the control group without pulmonary embolism (n=129). The data were collected from May 2018 to May 2023 in hospital settings. Type 2 diabetes mellitus was diagnosed according to the criteria of the American Diabetes Association (12). Pulmonary embolism was confirmed or excluded by the computed tomography pulmonary angiogram (CTPA/CTPE). We retrospectively evaluated the hospital records of both type 2 diabetes mellitus patients, with and without pulmonary embolism, residing in the area of northeastern Bosnia and Herzegovina (Tuzla, Lukavac, Živinice, Gračanica, Čelić, Teočak, Sapna, Kalesija, Gradačac, Srebrenik, Kladanj, Doboj-Istok, Banovići, Brčko distrikt). Since all our patients had undergone laboratory and CT diagnostics in hospital conditions, we used the hospital's database as a primary data source, alongside an additional cross-relational search of the database.

Procedure and ethical considerations

The study was aproved by the ethical comittee of University Clinical Center Tuzla No 02-09/2-79/19. The written consent was granted from each study participants.

Measures

In all patients with type 2 diabetes mellitus, we analyzed the following variables: anamnesis and physical exam, anthropometric parameters (age, sex, body weight, body height, body mass index, waist circumference), laboratory parameters (troponin, D-dimer, CRP, fibrinogen, uric acid, glucose, total serum cholesterol, HDL cholesterol, LDL cholesterol, triglycerides), systolic and diastolic arterial blood pressure, antiphospholipid antibodies (APA), HOMA-IR index, rate of adverse clinical events in pulmonary embolism (need for inotropic catecholamine support, fibrinolysis, cardiopulmonary resuscitation) and rate of intrahospital mortality from pulmonary embolism (in-hospital death within 10 days of hospital admission).

The exclusion criteria of the study were as follows: (1) Patient with cardiac conditions that are known to cause derangements in troponin levels and would therefore

act as a confounding factor in the study (including acute myocardial infarction, chronic heart failure, patients who had PTCA or CABG surgery), (2) Patient with known comorbid septic or inflammatory conditions that are known to cause derangements in laboratory parameters, since these would also act as a confounding factor in the study (including acute infectious diseases, septic conditions, pneumonia, malignancy, stroke, peripheral arterial disease, chronic kidney disease, liver disease, gout, systemic connective tissue diseases), (3) Patients with hormone replacement therapy, use of oral contraceptives and medications that could affect the lipid profile and patients with history of tobacco smoking.

Complications were registered as adverse clinical events in pulmonary embolism: need for inotropic cathecholamine support, fibrinolysis, cardiopulmonary resuscitation and in-hospital death within 10 days of hospital admission.

Statistical analysis

Statistical analysis was conducted using SPSS version 17.0 (Chicago, IL, USA) to analyze the data and derive meaningful conclusions. Descriptive statistics were employed to summarize the data, including measures of central tendency (mean) and measures of dispersion (standard deviation). The significance of differences between samples was assessed using both parametric and nonparametric tests, depending on the nature of the data.

Continuous data were presented as means ± standard deviation (SD) and were compared using an unpaired Student's t-test. This test allowed us to evaluate the statistical significance of differences between the means of two independent groups. The t-test was appropriate for comparing continuous variables such as age, weight, height, BMI, waist circumference, glucose, CHOL, HDL, LDL, TGL, systolic blood pressure, diastolic blood pressure, troponin, D-dimer, CRP, uric acid, fibrinogen, and HOMA-IR.

Categorical variables were reported as frequencies (%) and were compared using the chi-square test. This test enabled us to assess the association between categorical variables and determine if any statistically significant differences existed between the groups. Sex distribution, antiphospholipid antibodies (APA), inotropic support, fibrinolysis, cardiopulmonary resuscitation (CPR) and death status were analyzed using the chi-square test.

Statistical hypotheses were tested at a significance level (□) of 0.05. Differences between the samples were considered statistically significant if the p-value was less than 0.05. The p-value provides an indication of the probability that the observed differences occurred by chance alone. A p-value less than 0.05 suggests a significant association or difference between the groups.

Additionally, logistic regression analysis was performed to assess the predictors of pulmonary embolism (PE) in T2DM patients. This analysis allowed us to determine the influence of various independent variables, such as troponin, D-dimer, CRP, uric acid, HOMA-IR, diastolic blood pressure, on the likelihood of experiencing PE. Odds ratios (ORs) and their corresponding 95% confidence intervals (CIs) were calculated to estimate the magnitude of the associations. Logistic regression provides valuable insights into the predictive ability of these variables and their significance in relation to the occurrence of PE in T2DM patients.

4. RESULTS

Demographic and Clinical Characteristics

Among the total of 294 patients with type 2 diabetes mellitus, 165 patients had PE, while 129 patients did not have PE. The mean age of patients with PE was 70.02 years (SD = 13.40), slightly higher than the mean age of patients without PE, which was 67.45 years (SD = 10.07) (p = 0.07). The distribution of sex was similar between the two groups, with 98 females (59.4%) and 67 males (40.6%) in the PE group, and 76 females (58.9%) and 53 males (41.1%) in the non-PE group (p = 1).

Clinical characteristics and stratification of T2DM patients based on pulmonary embolism status are presented in *Table 1.*

Data are mean (± SD); Independent t-test was used for continuous data while chi-square test was used for categorical data; BMI, body mass index, CHOL, total serum holesterol; LDL, low-density lipoprotein; HDL, high-density lipoprotein; CRP, C-reactive protein; HOMA-IR,

Parameter	Level	PE N = 165	No PE N = 129	P
Age (N)		70.02 (13.40)	67.45 (10.07)	0.07
Sex (%)	Female	98 (59.4)	76 (58.9)	1
	Male	67 (40.6)	53 (41.1)	
Weight (kg)		92.14 (13.56)	92.79 (10.22)	0.65
Height (cm)		169.06 (9.19)	169.78 (9.15)	0.508
BMI		32.16 (3.80)	32.24 (2.71)	0.837
Waist circumference (cm)		115.46 (9.94)	117.18 (9.85)	0.141
Glucose (mmol/L)		8.58 (2.78)	8.80 (1.80)	0.422
CHOL (mmol/L)		5.33 (0.99)	5.24 (1.08)	0.458
HDL (mmol/L)		0.90 (0.36)	0.90 (0.30)	0.997
LDL (mmol/L)		4.30 (0.97)	4.34 (1.08)	0.716
TGL (mmol/L)		3.99 (5.62)	3.99 (4.47)	1
Systolic blood pressure (mmHg)		147.82 (14.25)	147.43 (12.43)	0.809
Diastolic blood pressure (mmHg)		94.52 (6.77)	96.40 (8.97)	0.041
Troponin (pg/ml)		148.17 (462.50)	22.27 (46.43)	0.002
D-dimer (mg/L)		4.44 (0.54)	1.96 (1.38)	<0.001
CRP (mg/L)		115.93 (77.79)	52.20 (56.15)	<0.001
Uric acid (μmol/L)		404.41 (81.46)	424.47 (71.24)	0.028
Fibrinogen (g/L)		4.71 (0.87)	4.42 (0.91)	0.005
HOMA IR		3.19 (0.36)	3.02 (0.49)	0.001
Death (%)	No	142 (86.1)	126 (97.7)	0.001
	Yes	23 (13.9)	3 (2.3)	

Table 1. Clinical characteristics and stratification of T2DM patients based on pulmonary embolism status

Parameter	Level	Death N = 26	No Death N = 268	P
Age (N)		80.54 (10.69)	67.76 (11.63)	<0.001
Sex (%)	Female	17 (65.4)	158 (58.6)	0,642
	Male	9 (34.6)	111 (41.1)	
Weight (kg)		85.04 (8.62)	93.14 (12.26)	0.001
Height (cm)		167.31 (8.79)	169.57 (9.19)	0.229
BMI		30.29 (1.99)	32.38 (3.41)	0.002
Waist circumference (cm)		108.85 (8.99)	116.93 (9.73)	<0.001
Glucose (mmol/L)		9.42 (4.34)	8.61 (2.12)	0.097
CHOL (mmol/L)		5.09 (0.86)	5.31 (1.05)	0.311
HDL (mmol/L)		1.09 (0.47)	0.88 (0.31)	0.002
LDL (mmol/L)		3.97 (0.70)	4.35 (1.04)	0.073
TGL (mmol/L)		5.33 (9.74)	3.86 (4.46)	0.164
Systolic blood pressure (mmHg)		140.38 (15.29)	148.35 (13.09)	0.004
Diastolic blood pressure (mmHg)		92.12 (8.96)	95.65 (7.68)	0.028
Troponin (pg/ml)		516.28 (1008.50)	51.86 (81.44)	<0.001
D-dimer (mg/L)		4.30 (1.08)	3.26 (1.60)	0.001
CRP (mg/L)		166.23 (82.85)	80.37 (70.94)	<0.001
Uric acid (µmol/L)		411.35 (55.37)	413.40 (79.57)	0.898
Fibrinogen (g/L)		4.64 (0.99)	4.58 (0.89)	0.754
HOMA IR		3.11 (0.37)	3.11 (0.44)	0.956
APA (%)	0	26 (100.0)	265 (98.9)	1
	1	0 (0.0)	3 (1.1)	
Inotropic support (%)	0	24 (92.3)	264 (98.5)	0.159
	1	2 (7.7)	4 (1.5)	
Fibrinolysis	0	26 (100.0)	268 (100.0)	NA
CPR (%)	0	23 (88.5)	266 (99.3)	0.001
	1	3 (11.5)	2 (0.7)	
Death (%)	0	0 (0.0)	268 (100.0)	<0.001
	1	26 (100.00)	0 (0.00)	
Group (%)	0	3 (11.5)	126 (47.0)	0.001
	1	23 (88.5)	142 (53.0)	

Table 2. Stratification of T2DM patients based on mortality

Homeostatic Model Assessment for Insulin Resistance)

Data are mean (± SD); Independent t-test was used for continuous data while chi-square test was used for categorical data, BMI, body mass index, CHOL, total serum holesterol; LDL, low-density lipoprotein; HDL, high-density lipoprotein; CRP, C-reactive protein; HOMA-IR, Homeostatic Model Assessment for Insulin Resistance); APA, antiphospolipid antibodies; CPR, cardiopulmonary resuscitation;

According to the results presented in *Table 1*, there were no significant differences in body weight, body height, BMI, waist circumference, glucose, CHOL (total serum cholesterol), HDL (high-density lipoprotein), LDL (low-density lipoprotein), TGL (triglycerides), and systolic blood pressure between the two groups ($p > 0.05$). However, diastolic blood pressure showed a statistically significant difference, with a mean of 94.52 mmHg (SD = 6.77) in the PE group and 96.40 mmHg (SD = 8.97) in the non-PE group ($p = 0.041$). Troponin levels were significantly higher in the PE group with a mean of 148.17 ng/mL (SD = 462.50), compared to the non-PE group with a mean of 22.27 ng/mL (SD = 46.43) ($p = 0.002$). D-dimer levels and CRP (C-reactive protein) levels were significantly elevated in the PE group compared to the non-PE group ($p < 0.001$). Similarly, uric acid levels and fibrinogen levels were significantly higher in the PE group ($p = 0.028$ and $p = 0.005$, respectively). HOMA IR (homeostatic model assessment of insulin resistance) was significantly higher in the PE group compared to the non-PE group ($p = 0.001$). Patients with pulmonary embolism in T2DM proved to have significantly more in-hospital death within 10 days of hospital admission ($p<0.001$), compared to patients with T2DM, without pulmonary embolism (*Table 1*).

Regarding mortality, *Table 2* displays the stratification of T2DM patients based on death status. Among the total of 294 T2DM patients, 26 patients died, while 268 patients survived. Patients who died had a significantly higher mean age of 80.54 years (SD = 10.69) compared to those who survived, with a mean age of 67.76 years (SD = 11.63) ($p < 0.001$).

There were no significant differences in sex distribution, height, glucose, CHOL, LDL, TGL, fibrinogen, and uric acid levels between the two groups ($p > 0.05$). Patients who died had a significantly lower weight (mean = 85.04 kg, SD = 8.62) compared to those who survived (mean 93,14 kg, SD =12.26), and significantly lower waist circumference (mean = 108.85 cm, SD = 8.99) compared to those who survived (mean = 116.93 cm, SD = 9.73) ($p < 0.001$). BMI was significantly higher in the group that survived ($p = 0.002$). HDL levels were significantly lower in the group that survived (mean = 0.88 mmol/L, SD = 0.31) compared to the group that died (mean = 1.09 mmol/L, SD = 0.47) ($p = 0.002$).

Variable	OR	95%CI	P-value
DBP	0.99	[0.94;1.05]	0.83
CRP	1	[1.00;1.01]	0.41
Uric Acid	1	[0.99;1.00]	0.29
HOMA IR	4.45	[1.43;12.91]	0.01
D-dimer	8.93	[4.69;16.97]	< 0,0001
Troponin	1.02	[1.02; 1.03]	0.001

Table 3. Factors predicting pulmonary embolism in patients with type 2 diabetes mellitus using regression model. DBP, diastolic blood pressure; CRP, C-reactive protein; HOMA-IR, Homeostatic Model Assessment for Insulin Resistance);

Diastolic blood pressure was significantly lower in the group that died (mean = 92.12 mmHg, SD = 8.96) compared to the group that survived (mean = 95.65 mmHg, SD = 7.68) ($p = 0.028$).

Troponin levels, D-dimer levels, and CRP levels were significantly higher ($p < 0.001$) in the group that died. Fibrinogen (p=0.75), HOMA-IR (p=0,95), and uric acid (p=0.89) level were not significantly higher in the group

that died compared to the group that survived Additionally, patients who received cardiopulmonary resuscitation (CPR) had a significantly higher mortality rate (p = 0.001).*(Table 2)*

The logistic regression analysis was performed to identify the factors predicting the occurrence of pulmonary embolism (PE) in patients with type 2 diabetes mellitus. The results of the analysis are presented in *Table 3*.

The odds ratio (OR) for diastolic blood pressure (DBP) was 0.99 (95% CI: 0.94 to 1.05), indicating that there was no significant association between DBP and the risk of PE (p = 0.82). Similarly, CRP showed an OR of 1 (95% CI: 1.00 to 1.01), suggesting no significant association with PE risk (p = 0.41). Uric acid also did not demonstrate a significant association, with an OR of 1 (95% CI: 0.99 to 1.00) and p-value of 0.29. In contrast, troponin levels showed a statistically significant association with PE, with an OR of 1.02 (95% CI: 1.02 to 1.03) and p-value of 0.001. Higher troponin levels were found to be associated with an increased risk of PE in T2DM patients. D-dimer levels were strongly associated with PE risk, with an OR of 8.93 (95% CI: 4.69 to 16.97) and p-value of less than 0.0001. This suggests that elevated D-dimer levels significantly increase the probability of developing PE in T2DM patients. Lastly, HOMA IR exhibited a statistically significant association with PE risk, with an OR of 4.45 (95% CI: 1.43 to 12.91) and p-value of 0.01. This indicates that higher HOMA IR values are associated with an increased likelihood of experiencing PE in T2DM patients.

5. DISCUSSION

The mechanisms of pulmonary embolism in patients with T2DM have not been fully understood. The main source of data connecting T2DM with pulmonary embolism is still based on retrospective analysis of small databases (8,13-14). Many studies highlight the importance of routine detection of elevated prothrombotic and proinflammatory markers in T2DM because of the higher cardiovascular risk. It may even be considered unethical not to search for these abnormalities when we know their frequency and poor prognostic implications in patients with T2DM.

In the present study, prothrombotic and proinflammatory markers in T2DM were significantly higher in patients with pulmonary embolism compared to the patients without pulmonary embolism. Prognostic stratification of patients with pulmonary embolism in T2DM is very important in the treatment and potential improvement of clinical outcomes. The current analyses suggest a strong indication for a wide assessment of metabolic anomalies and the need for a multidisciplinary approach to the patients with type 2 diabetes mellitus and its comorbidities.

In the present study there were no significant differences in body weight, body height, BMI, waist circumference, glucose, CHOL (total serum cholesterol), HDL (high-density lipoprotein), LDL (low-density lipoprotein), TGL (triglycerides), and systolic blood pressure between two groups (p > 0.05). In a study by Ray et al. (15), patients with elevated fasting glucose (blood glucose ≥11.1 mmol/L) had a high incidence of pulmonary embolism, which is not consistent with the results of our research. In a study by Ageno (4), hypercholesterolemia and low HDL cholesterol were linked to an increased risk of PE, which is not in accordance with our results. In a study by Ray et al. (15), total serum cholesterol was not significantly different between patients with pulmonary embolism and controls, which is consistent with the results of our research.

Elevated values of plasma fibrinogen can have a direct impact on the initiation of thrombosis, on the structural properties of the thrombus, such as the resistance of the thrombus to mechanical stress, fibrinolytic dissolution, and the size of the thrombus, which together represent factors that determine whether the thrombus will rupture and form emboli that will cause pulmonary embolism or not. It remains unclear whether elevated fibrinogen is the cause or just a marker of deep vein thrombosis and/or pulmonary embolism. Fibrinogen increases plasma viscosity and platelet aggregation (16) . The present results showed that patients with pulmonary embolism in T2DM had significantly higher values of CRP, fibrinogen, and uric acid, which is consistent with the results of the previous studies (17,18). The results of our research indicate that fibrinogen, CRP, and uric acid could play an important role in defining the severity of T2DM and potential complications, including pulmonary embolism.

In this study troponin levels were significantly higher in the PE group, compared to the non-PE group (p = 0.002). D-dimer levels were significantly elevated in the PE group compared to the non-PE group (p < 0.001). According to the results, troponin and D-dimer were significant predictors of pulmonary embolism in the T2DM (p < 0.001).

T2DM may play a key role in the pathogenesis of pulmonary embolism and may be a link between venous thrombosis, atherosclerosis, and pulmonary embolism. Elevated troponins proved to be good predictors of a possible bad outcome in acute pulmonary embolism (10), which is in accordance with the results of our study.

The identification of people with T2DM has the ultimate goal of encouraging lifestyle changes that can simultaneously affect all negative metabolic changes in the body and thus reduce the risk of cardiovascular disease, including pulmonary embolism (14). These assessments can very easily be added to the standard clinical risk assessment procedures and be of significant value in future secondary prevention planning.

Measuring troponin values in patients with pulmonary embolism in the T2DM could potentially clearly separate patients with high and intermediate-risk pulmonary embolism from patients with low-risk pulmonary embolism, which is an important clinical implication of our study. In the study by Demir et al. (19), troponin was elevated in 81.35% of patients with pulmonary embolism, which is consistent with the results of our study. According to the research by Kline et al. (20), elevation of troponin values due to pulmonary embolism is found in about 50% of patients, which is less compared to the results of our research.

Our study provides important insights into the strati-

fication of T2DM patients based on pulmonary embolism (PE) status and mortality outcomes. The results indicate several significant associations and highlight potential risk factors for these patient populations.

An improved understanding of the role that T2DM plays in the development of pulmonary embolism may help clinicians in acute care settings regarding the appropriate treatment and its impact on patient outcomes (1).

Prothrombotic, proinflammatory markers, and troponin should be measured in all patients with pulmonary embolism in T2DM, especially in conditions of unavailable emergency echocardiography, in order to become an imperative part of our routine clinical practice.

6. CONCLUSION

Prothrombotic, proinflammatory markers, and troponin may be used as additional prognostic factors of pulmonary embolism and its complications in patients with type 2 diabetes mellitus for short-term outcomes. Determination of troponin, D-dimer prothrombotic, and proinflammatory marker levels at admission to the hospital may help create a better risk stratification for patients with pulmonary embolism in the type 2 diabetes melitus. The presence of T2DM in patients with pulmonary embolism is associated with significantly higher rates of complications and mortality, and the right identification of these risk factors is necessary to reduce the risk.

- **Patient Consent Form:** All participants were informed about subject of the study.
- **Author's Contribution:** J.B. gave substantial contributions to the design of the work in acquisition, analysis, or interpretation of data for the work in article preparing for drafting or revising it critically for important intellectual content. J.B. also gave final approval of the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
- **Conflicts of interest:** There are no conflicts of interest.
- **Financial support and sponsorship:** None.

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