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Are the Clinical and Radiological Characteristics of Pulmonary Embolism Differential in Patients with Cancer?

Kanser Hastalarında Pulmoner Embolinin Klinik-Radyolojik Özellikleri Farklı mıdır?

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ABSTRACT

Background: In general, it is known that many cancers and chemotherapy regimens administered to prevent cancer increase the tendency for thrombosis by disrupting hemostasis physiology. In this study, the prognostic differences between pulmonary embolism (PE) in patients diagnosed with cancer and those without a cancer diagnosis were investigated.

Materials and Methods: The records of patients diagnosed with PE in our clinic between December 2021 and January 2023 were retrospectively examined. Patients were divided into 2 groups: those with and without a history of cancer. Clinical, demographic, radiological, and laboratory characteristics of the patients in both groups were compared. Pulmonary Embolism Severity Index (PESI) score was used for the prognostic evaluation of PE. For the classification of the severity of PE and early mortality assessment (EMD) patients were stratified into low, moderate-low, moderate-high, and high-risk categories. The data of these two groups were compared.

Results: A total of 108 patients, with a mean age of 65.5±18 years, were included in the study. Of these patients, 30 (27.7%) (Group 1) had a history of cancer, and 78 (72.3%) (Group 2) had no history of cancer. The mean duration of hospitalization was 7.3±5.4 days in Group 1 and 9.7±5.2 days in Group 2 ($p<0.05$). No significant difference was observed in D-dimer, brain natriuretic peptide, and troponin values ($p>0.05$). Thoracic computed tomography-angiography findings of both groups were also similar ($p>0.05$). In Group 1; mean PESI score and rate of the number of patients PESI-III and above were significantly higher ($p<0.05$). In terms of EMD, the rate of high-risk patients and incidence of hemodynamic instability were significantly higher in Group 1 ($p<0.05$). Concerning the 30 day mortality, the rate of number of patients in Group 1 was significantly higher ($p<0.05$).

Conclusion: The presence of an additional cancer diagnosis did not have a notable impact on the radiological and laboratory parameters of PE; however, it did significantly change the early mortality associated with PE.

Keywords: Pulmonary embolism, cancer, mortality

ÖZ

Amaç: Genel olarak birçok kanserin ve kanseri önlemek için verilen kemoterapilerin hemostaz fizyolojisini bozarak tromboza eğilimi artırdığı bilinmektedir. Bu çalışmada kanser tanısı olan olgularda gelişen pulmoner emboli (PE) ile kanser tanısı olmayan PE olguları arasındaki prognostik farklılıklar araştırılmıştır.

Gereç ve Yöntemler: Aralık 2021-Ocak 2023 tarihleri arasında kliniğimize PE tanısı ile yatan olguların dosyaları retrospektif olarak incelendi. Olgular öncesinde kanser tanısı olanlar ve olmayanlar olmak üzere 2 gruba ayrıldı. Her iki gruptaki olguların klinik, demografik, radyolojik ve laboratuvar özellikleri karşılaştırıldı. PE'nin prognostik değerlendirmesi için Pulmoner Emboli Şiddet İndeksi (PESİ) skoru kullanıldı, PE'nin şiddetinin sınıflandırılması ve erken mortalite değerlendirmesi (EMD) için olgular düşük, orta-düşük, orta-yüksek ve yüksek riskli olarak sınıflandırıldı. İki grubun verileri birbirleri ile karşılaştırıldı.

Bulgular: Çalışmaya yaş ortalaması 65,5±18 olan toplam 108 olgu dahil edildi. Olguların 30'unda (%27,7) (Grup 1) öz geçmişinde kanser öyküsü var iken, 78'inin (%72,3) (Grup 2) öz geçmişinde kanser öyküsü yoktu. Grup 1'de olguların ortalama hastanede yatış gün

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sayısı 7,3±5,4 gün iken Grup 2'de 9,7±5,2 gündü (p<0,05). İki grup arasında D-dimer, beyin natriüretik peptidi, Troponin değerlerinde fark izlenmedi (p>0,05). Her iki grubun toraks bilgisayarlı tomografi-anjiyo bulguları benzerdi (p>0,05). Grup 1'de ortalama PESİ skoru, PESİ-III ve üstü olgu sayısı oranı anlamlı olarak yüksekti (p<0,05). EMD açısından Grup 1'de yüksek riskli olgu sayısı oranı ve hemodinamik instabilite varlığı saptanan olgu sayısı oranı anlamlı olarak yüksekti (p<0,05). Otuz günlük mortalite açısından Grup 1'de olgu sayısı oranı istatistiksel anlamlı olarak fazlaydı (p<0,05).

Sonuç: Kanser tanısı varlığı PE'nin radyolojik ve laboratuvar değerlerini belirgin şekilde etkilememektedir, fakat kanser tanısı PE'nin erken mortalitesini anlamlı oranda değiştirmektedir.

Anahtar Kelimeler: Pulmoner emboli, kanser, mortalite

Introduction

Pulmonary embolism (PE) is characterized by occlusion of pulmonary arteries by thrombus, and it has an incidence of 23%-269 per 100,000 population annually. Although treatment outcomes are favorable with rapid and early diagnosis, mortality may exceed 50% in patients who cannot be treated for various reasons (1). There are more than 30 identified risk factors categorized as major, moderate and weak for PE (2).

PE is a common complication in individuals with cancer, attributable both to its presence as a risk factor and the heightened risk associated with chemotherapy regimens administered for cancer treatment. Although conclusive evidence is lacking, the exponential increase in PE risk among patients with cancer is linked to the intrinsic prothrombotic activity of cancer cells, a tendency toward hypercoagulation mediated by cytokine release, and the prothrombotic effects of chemotherapy treatment (3).

With advances in diagnostic/imaging methods, particularly thoracic computed tomography-angiography (CT-angiography), along with improvements in treatment options, the mortality of PE has been decreasing over the years (4,5). On the other hand, it is undeniable that the incidence of PE is likely to rise in patients with cancer due ongoing developments in diagnostic and therapeutic methods, advances in both the diagnosis and treatment of oncological diseases, and the extended life expectancy of patients with cancer (6).

Mortality from PE is directly correlated with comorbidities, notably cancer, and age (4). The hypothesis of this study was that the clinical, radiologic and laboratory aspects of PE in patients diagnosed with cancer may differ from those without a cancer diagnosis; and to explore this, cases of PE diagnosed with cancer were compared to those without a cancer diagnosis.

Materials and Methods

We conducted a retrospective study in accordance with the Declaration of Helsinki and obtained approval from the İstanbul Medeniyet University Göztepe Training and Research Hospital Clinical Research Ethics Committee (decision no: 2023/0587, date: 20.09.2023). Since our study was a retrospective file-scanning study, an informed consent form was not obtained. We retrospectively examined the records of patients diagnosed with PE by thoracic CT angiography at our clinic between December 2021 and January 2023 and documented their clinical and demographic characteristics. A detailed analysis of the thoracic CT angiograms was performed. The analysis included documenting the bilateral distribution of detected thrombi within the pulmonary arterial system, presence of thrombi in the main pulmonary root, right and left main pulmonary arteries, and bilateral lobar, segmental, and subsegmental branches. We also noted the presence of PE-related pleural effusion and parenchymal infiltration. We also recorded the routine laboratory values obtained during the diagnosis and treatment of PE, such as hemogram, white blood count (WBC), platelets (PLT), neutrophils, neutrophil percentage, lymphocytes, lymphocyte percentage, mean platelet volume (MPV), C-reactive protein (CRP), procalcitonin (PRC), alanine aminotransferase (ALT), aspartate aminotransferase, lactate dehydrogenase, urea-creatinine, electrolytes, troponin, brain natriuretic peptide (BNP), and D-dimer levels. Additionally, the highest values of CRP, PRC, BNP, and troponin observed during hospitalization were documented, as were the oxygen saturation and partial arterial pressure of oxygen values from arterial blood gas examinations during hospitalization. Echocardiography and Doppler ultrasonography (USG), if available, were recorded, noting the presence of right ventricular overload and pulmonary artery systolic pressure (PABs) on echocardiography as well as the presence of thrombus on Doppler USG.

Evaluation of Prognostic Status and Early Mortality

We used the Pulmonary Embolism Severity Index (PESI) scoring system developed by Aujesky et al. (7) for the prognostic evaluation of PE (Supplement 1). In accordance with the European Society of Cardiology (ESC) guidelines, Class I and II in PESI scoring were considered low-risk groups, whereas Class III and above (Class III-

IV-V) in PESI scoring were considered high-risk in terms of early mortality. For the classification of the severity of PE and early mortality assessment (30 day mortality) (EMD), patients were stratified into low, moderate-low, moderate-high, and high risk categories (8) (Supplement 2). Furthermore, hemodynamic instability in PE was defined as the presence of cardiac arrest, obstructive shock, and persistent hypotension according to the ESC guidelines (8) (Supplement 3). The points from these scoring systems were recorded for each patient.

Patients were divided into 2 groups: those with a history of cancer (Group 1) and those without a history of cancer (Group 2). The duration of cancer diagnosis and patients who underwent chemotherapy were also documented for further analysis and comparison between the two groups.

Patients with an uncertain diagnosis of PE, those diagnosed with cancer by methods other than thoracic CT angiography [ventilation perfusion (V/Q) scintigraphy and/or clinical diagnosis], pregnant women, and those under 18 years of age were excluded. Artificial intelligence-supported technologies were not used in this paper.

Statistical Analysis

Statistical analysis was performed using SPSS 17.0 (IBM IncRelased 2008. SPSS Statistics for Windows (Chicago, USA). In descriptive statistics, continuous variables were expressed as mean ± standard deviation for normally distributed values and as median (minimum-maximum) for values not fitting the normal distribution. Categorical variables are expressed as percentages. Normal distribution was assessed using the Kolmogorov-Smirnov test. The chi-square, independent sample t-test and Mann-Whitney U tests were employed to evaluate data from groups, when necessary. For all tests, $p<0.05$ was considered significant.

Results

We reviewed the medical records of a total of 110 patients admitted to the Chest Diseases clinic with a diagnosis of PE between December 2021 and January 2023. Two patients were excluded because their diagnosis was made by V/Q scintigraphy. Thus, the final analysis included a total of 108 patients, 62 (52.4%) females and 46 (42.6%) males, with a mean age of 65.5±18 years. Of these patients, 30 (27.7%) (Group 1) had a history of cancer and 78 (72.3%) (Group 2) had no history of cancer. While 86 (79.6%) of the patients had comorbidities, whereas 22 (20.4%) did not. The most common comorbidity was hypertension in 38 (35.1%) patients. The mean duration of hospitalization was 8.8±5.2 days for all patients, specifically 7.3±5.4 days in Group 1 and 9.7±5.2 days in Group 2 (p=0.049).

The cancer group included 8 (26.6%) patients with lung cancer, 6 (20%) with breast cancer, 6 (20%) with colon cancer, 3 (10%) with ovarian cancer, 2 (6. 6%) with bladder cancer, 2 (6.6%) with pancreatic cancer, 2 (6.6%) with glioblastoma and 1 (3.3%) with prostate cancer (Figure 1).

An analysis of the laboratory values showed that the mean PLT, MPV, and D-dimer values for Group 1 during admission were 208566±95241x103/µL, 10. 1±1fl, and 11.47±11.2 µg/L, respectively, while these parameters were 254794±98108x103/µL, 10.8±1.4fl, and 10.5±9.6 µg/L for Group 2, respectively (p=0.029, p=0.013, p=0.596). The highest laboratory values at admission and during hospitalization are presented in Table 1.

An analysis of the radiologic findings showed that the number of patients with embolism of the right main pulmonary artery was 4 (13.3%) in Group 1 vs. 13 (16.6%) in Group 2 (p=0.844) while those with embolism of the left main pulmonary artery was 0 in Group 1 and 5 (6.4%) in Group 2 (p=0.355). The detailed radiologic examination results (Thoracic CT angiography, echocardiography, bilateral lower extremity venous doppler USG) of the patients are presented in Table 2.

In Group 1, 28 patients (93.3%) patients received low-molecular-weight heparin (LMWH) and 2 patients (6.7%) received oral anticoagulant therapy. In Group 2, 30 cases (38.5%) received LMWH, while 11 patients (14.1%) received oral anticoagulants and 37 patients (47.4%) received new oral anticoagulants.

The mean PESI score was 121.6±23.3 in Group 1 vs. 95.5±35.4 in Group 2 (p<0.001). The mean number of patients with PESI-III and above was 28 (93.3%) in Group 1 vs. 46 (58.9%) in Group 2 (p=0.024) (Table 3). In terms of EMD, there were 8 high-risk patients (26.9%) in Group 1 and 9 (5.8%) were in Group 2 (p=0.05). The number of patients with hemodynamic instability was 8 (26.6%) in Group 1 and 8 (10.2%) in Group 2 (p=0.032) (Figure 2). The number of

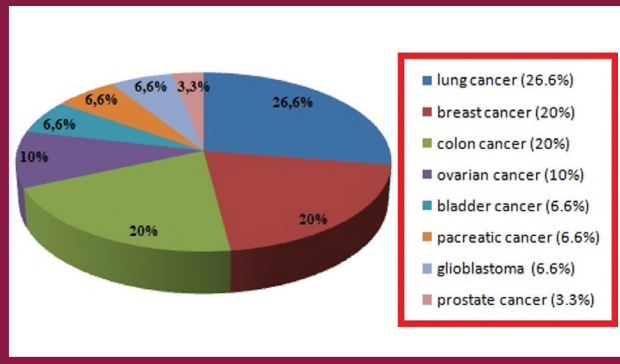

Figure 1. Distribution of cancer diagnoses of patients in Group 1

Table 1. Clinical, demographics, laboratory, and treatment characteristics of patients

	History of cancer (Group 1; n=30)	No history of cancer (Group 2; n=78)	p-value
Age (mean ± SD)	62.9±15.1	66.4±19	0.363
Gender (F/M) (n%)	14-46.7%/16-53.3%	48-61.5%/30-38.5%	0.104
Comorbidities			
Comorbidities (+/-) (n%)	30-100%	56-71.8%/22-28.2%	**0.003**
Hypertension (n%)	8-26.6%	30-38.4%	0.355
Diabetes (n%)	9-30%	16-20.5%	0.428
CAD (n%)	2-6.6%	8-10.2%	0.837
Heart failure (n%)	0-0%	8-10.2%	0.158
COPD (n%)	3-10%	7-8.9%	0.870
Asthma (n%)	1-3.3%	5-6.4%	0.876
CRD (n%)	0-0%	2-2.5%	0.929
Temparature (°C) (mean ± SD)	36.5±0.2	36.4±0.2	0.120
Pulse (min.) (mean ± SD)	97±27	95±19	0.678
SBP (mmHg) (mean ± SD)	114±28	127±27	**0.019**
DBP (mmHg) (mean ± SD)	70±14	73±13	0.239
Duration of hospitalization (days) (mean ± SD)	7.3±5.4	9.7±5.2	**0.049**
Laboratory values			
WBC (10^3/µL) (mean ± SD)	9086±3849	10828±4042	**0.045**
Hgb (g/dL) (mean ± SD)	10.9±2	12±2	**0.004**
PLT (10^3/µL) (mean ± SD)	208566±95241	254794±98108	**0.029**
MPV (fl) (mean ± SD)	10.1±1	10.8±1.4	**0.013**
Sodium (mEq/L) (mean ± SD)	134±4.2	137±3.8	**0.001**
Potassium (mEq/L) (mean ± SD)	4.1±0.6	4.3±0.8	0.119
CRP (mg/dL) (mean ± SD)	90±67	73±77	0.279
PRC (qg/L) (mean ± SD)	0.30±0.5	0.43±1.6	0.754
LDH (U/L) (mean ± SD)	356±249	274±151	0.052
D-dimer (µg/L) (mean ± SD)	11.47±11.2	10.5±9.6	0.753
Urea (mg/dL) (mean ± SD)	53±83	43±27	0.358
Creatinine (mg/dL) (mean ± SD)	0.76±0.2	0.99±0.5	**0.039**
ALT (U/L) (mean ± SD)	26±25	30±37	0.580
AST (U/L) (mean ± SD)	32±31	32±36	0.987
Albumin (g/L) (mean ± SD)	32±6.2	37±5.9	**0.002**
BNP (ng/L) (mean ± SD)	3173±4876	3103±5607	0.966
Troponin (ng/L) (mean ± SD)	32±37	50±90	0.359
ABG PaO_2 (mmHg) (mean ± SD)	72±20	62±14	0.075
Hospitalization SaO_2 (%)	91±4	90±4	0.485
PESI score	121.6±23.3	95.5±35.4	**<0.001**

SD: Standard deviation, F/M: Female/Man, CAD: Coronary artery disease, COPD: Chronic obstructive pulmonary disease, CRD: Chronic renal disease, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, WBC: White blood count, Hgb: Hemoglobin, PLT: Platelets, MPV: Mean platelet volume, CRP: C-reactive protein, PRC: Procalcitonin, LDH: Laktate dehydrogenase, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, BNP: Brain natriuretic peptide, ABG: Arterial blood gas, PESI: Pulmonary Embolism Severity Index, SaO_2: Oxygen saturation, PaO_2: Partial arterial pressure of oxygen, Min.: Minimum

Table 2. Radiological and ECHO characteristics of patients

Thoracic CT angiography findings	History of cancer (Group 1; n=30)	No history of cancer (Group 2; n=78)	p-value
Presence of embolism in the main pulmonary artery (n%)	0-0%	1-1.2%	1.000
Presence of embolism in the left pulmonary artery (n%)	0-0%	5-6.4%	0.355
Embolization in the right pulmonary artery (n%)	4-13.3%	13-16.6%	0.844
Presence of embolism in both pulmonary arteries (n%)	6-20%	21-26.9%	0.583
Presence of embolism in unilateral segment branches (n%)	9-30%	25-32%	0.938
Presence of embolism in bilateral segment branches (n%)	18-60%	41-52.5%	0.747
Presence of embolism in unilateral subsegment branches (n%)	9-30%	21-26.9%	1.000
Presence of embolism in bilateral subsegment branches (n%)	16-53.3%	43-55.1%	0.903
Presence of pleural fluid due to embolism (n%)	8-26.6%	22-28.2%	0.989
Presence of parenchymal infarction area (n%)	14-46.6%	38-48.7%	0.873
Presence of thrombi on Doppler USG (n%)	10-33.3%	21-26.9%	0.515
ECHO presence of right ventricular involvement (n%)	9-30%	34-43.5%	0.380
ECHO PAP value (mmHg) (mean ± SD)	31.9±11.3	40.6±15.8	**0.026**

ECHO: Echocardiography, PAP: Pulmonary artery pressure, USG: Ultrasonography, CT: Computed tomography

Table 3. Distribution of patients according to PESI scores

PESI score	History of cancer (Group 1; n=30)	No history of cancer (Group 2; n=78)	p-value
PESI-I (n%)	0	13-16.6%	0.017
PESI-II (n%)	2-6.6%	19-24.3%	0.037
PESI-III (n%)	5-16.6%	19-24.3%	0.389
PESI-IV (n%)	9-30%	14-17.9%	0.171
PESI-V (n%)	14-46.6%	13-16.6%	0.171
PESI-III and above	28-93.3%	46 58.9%	0.001

PESI: Pulmonary Embolism Severity Index

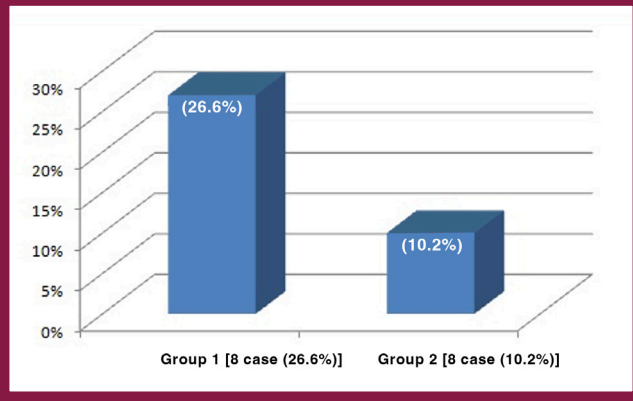

Figure 2. The number of patients with hemodynamic instability

patients who died within 30 days was 7 (23.3%) in Group 1 and 7 (8.97%) in Group 2 (p=0.047) (Figure 3).

Upon analyzing the treatment characteristics of patients in Group 1, it was found that 23 (76.7%) patients underwent chemotherapy, whereas 7 (23.3%) did not receive chemotherapy. Among patients who received chemotherapy, the mean time elapsed between chemotherapy and the onset of PE was 397±856.14 days. Among the included

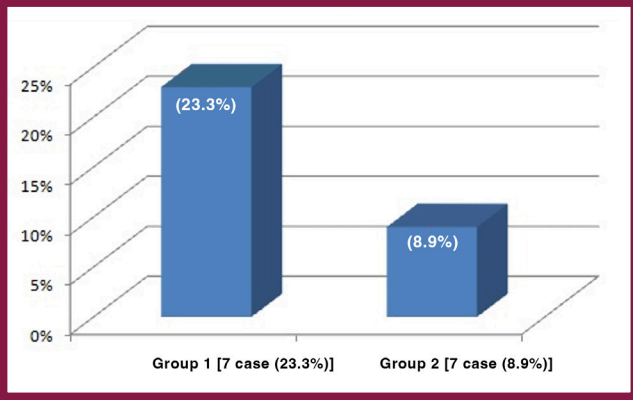

Figure 3. Death within 30 days

patients, 13 (56.5%) were diagnosed with PE within the first 30 days following chemotherapy.

Discussion

In this retrospective observational study, we examined the clinical, laboratory, and radiological characteristics of patients with PE with and without a diagnosis of cancer. PESI scores were higher in the PE group with cancer. Group 1 patients had statistically significantly higher PESI-III scores and higher scores, a higher proportion of high-risk patients in terms of PE, and a greater incidence of hemodynamic instability at the time of PE diagnosis. In terms of laboratory parameters, the WBC, HB, MPV, and PLT levels were lower in the cancer group than in the non-cancer group. No significant differences were observed in D-dimer, BNP, and troponin levels. Radiologically, there was no difference between the two groups. In the cancer group, most patients (56%) underwent chemotherapy within the first month. Interestingly, the duration of hospitalization was shorter in the cancer group.

Wang et al. (9) investigated the association between cancer and PE in two groups of patients with PE and cancer (n=52) and without cancer (n=44). They found that WBC counts were significantly higher in the cancer group than in the non-cancer group. In another study by Connolly et al. (10) involving 4,405 cancer outpatients receiving chemotherapy, the leukocyte levels of patients who developed PE were elevated. The authors suggested that leukocytes directly contribute to thrombus formation and disease progression by releasing tissue factors and vascular endothelial growth factor. In the present study, WBC and PLT counts were significantly lower in the cancer group. Considering that myelosuppression in bone marrow is a common side effect of chemotherapy drugs (11) we believe that this difference may be attributed to the fact that majority of our patients (56.5%) recently underwent chemotherapy.

An evaluation of the radiologic findings of the patients (thoracic CT angiography, echocardiography, Doppler USG) demonstrated a significant difference in Group 2 in terms of echocardiography-PABs; otherwise, the radiologic features of both groups were similar. The results are contradictory in the literature on this topic. Some publications suggest a higher incidence of central PE on thoracic CT angiography in patients with cancer and PE (12,13,14), whereas other studies (9,15), including ours, found no significant difference. Radiologically, there was no difference between the two groups in our study. One hypothesis on this topic is that the embolic material entering the pulmonary artery may fragment and evenly distribute to multiple segmental or subsegmental vessels, resulting in occlusion. This way, we can explain why we could not find the difference. Another radiological difference noted was the higher prevalence of echocardiography -derived PABs pressures in Group 2, but this finding may be coincidental or due to a significantly higher proportion of cardiac diseases in Group 2.

The risk of venous thromboembolism (VTE) is known to increase during cancer treatment, with chemotherapy contributing to thrombosis by showing toxic effects against the vascular endothelium and increasing cytokine release (16). A previous study reported a 5.3 fold higher risk of PE complications in patients with cancer treated with systemic chemotherapy compared with other treatments, highlighting the thrombogenic effects of systemic chemotherapy (17). Another study found a rate of 5.3% of VTE in 1921 patients receiving chemotherapy, with one-third experiencing PE complications (18). Otten et al. (19) detected VTE in 15 (7.3%) patients among a cancer group of 206 patients who underwent chemotherapy. When analyzing the duration of chemotherapy in these patients, it was observed that 86.6% received chemotherapy within the first month (9 patients were diagnosed with VTE during chemotherapy treatment, 2 patients within one week and 2 patients within the first month). Considering thatthe majority of our patients (56.5%) were diagnosed with PE within the first month of chemotherapy, chemotherapy-related PEs may be associated with the early phase of chemotherapy.

Most studies investigating the hospitalization duration of patients with PE, with or without a cancer diagnosis, have indicated longer hospital stays among patients with cancer (14,20). This could be attributed to older age, higher comorbidity, and potentially different treatment features for PE. Previous studies have shown a lower rate of thrombolytic administration in patients with cancer than in those without cancer, and the use of direct-acting oral anticoagulants has been associated with shorter hospitalization periods (20,21). In our

study, the majority of cancer patients (90%) were discharged with LMWH, which resulted in shorter hospitalizations.

PESI is commonly used to predict early mortality following PE. However, it hashas been developed for the general PE population, and its effectiveness in patients with cancer has not been extensively studied. In a literature review, Li et al. (22), who compared the sensitivity of PESI with other scoring methods in patients with cancer, reported that cancer-specific PE prognostic scores [Registro Informatizado de la Enfermedad Trombo Embólica (RIETE) and POMPE-C] outperformed PESI. Another study by Weeda et al. (23) compared the POMPE-C and RIETE criteria with PESI, revealing that the sensitivity of PESI was >96.0%, and the specificity was very low (<19%). In our study, the rates of patients with PESI-III and above (93.3%-58.9%) (p=0.024), high-risk (26.9%-5.8%) (p=0.05), and detection of hemodynamic instability (26.6%-10.2%) (p=0.032) were significantly higher in Group 1 compared with Group 2, and death within the first 30 days in group 1 (23.3%-8.9%) was also significantly higher than in Group 2. Given the lack of studies directly comparing PESI rates in patients with cancer in the literature, our study results suggest that PESI scoring can be valuable for predicting early mortality in this patient population.

However, it is important to acknowledge the limitations of this study, including itsits small sample size, retrospective design reflecting a single center experience, and the absence of cancer subgroups. Future research focusing specifically on PE in patients with lung cancer, which directly impacts cardiopulmonary reserve, may provide additional insights. These limitations should be considered when interpreting the results.

Conclusion

One significant finding from our investigation into the clinical, radiological, and laboratory aspects of PEs accompanied by cancer diagnosis was that the presence of an additional cancer diagnosis did not have a notable impact on the radiological and laboratory parameters of PE; however, it did significantly change the mortality associated with PE.

Ethics

Ethics Committee Approval: We conducted a retrospective study in accordance with the Declaration of Helsinki and obtained approval from the İstanbul Medeniyet University Göztepe Training and Research Hospital Clinical Research Ethics Committee (decision no: 2023/0587, date: 20.09.2023).

Informed Consent: Since our study was a retrospective file-scanning study, an informed consent form was not obtained.

Authorship Contributions

Surgical and Medical Practices: E.E.Y., Concept: S.D.T., Design: S.D.T., C.D., Data Collection or Processing: S.İ., S.S., Analysis or Interpretation: C.D., Literature Search: S.D.T., Z.N.T., Writing: S.D.T., C.D.

Conflict of Interest: No conflict of interest was declared by the authors.

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Supplement 1. PESI score

Predictors	PESI	
Age>80 years	Age/years	
Male sex	+10	
History of cancer	+30	
History of heart failure	+10	
History of chronic lung disease	+10	
Heart rate≥110	+20	
SBP <100 mmHg	+30	
Respiratory rate ≥30	+20	
Temperature <36 °C	+20	
Altered mental health	+60	
O_2 saturation <90%	+20	
	Low risk Class I: ≤65 Class II: 66-85	**High risk** Class III: 86-105 Class IV: 106-125 Class V: >125

PESI: Pulmonary Embolism Severity Index, SBP: Systolic blood pressure

Supplement 2. Classification of PE severity and the risk of early death

		Risk indicators		
Early mortality risk	**Hemodynamic instability**	**PESI Class III-IV**	**Right ventricular dysfunction on TTE or CT**	**Increased cardiac troponin levels**
High	+	+	+	+
Moderate-high	-	+	+	+
Moderate-low	-	+	Either (+) or both (-)	
Low	-	-	-	-

CT: Computed tomography, PESI: Pulmonary embolism severity index, PE: Pulmonary embolism, TTE: Transthoracic echocardiography

Supplement 3. Definition of hemodynamic ınstability in pulmonary embolism		
Cardiac arrest	**Obstructive shock**	**Persistent hypotension**
Presence of ardiac arrest requiring cardiopulmonary resuscitation	-Systolic blood pressure <90 mmHg or -The need for vasopressors to maintain systolic blood pressure ⩾90 mmHg despite adequate fluid support and -Presence of end-organ hypoperfusion (altered consciousness, cold-clammy skin, oliguria/anuria, increased serum lactate level)	-Systolic blood pressure <90 mmHg or -Decrease in systolic blood pressure by >40 mmHg (Lasting longer than 15 minutes and unexplained by new onset arrhythmia, hypovolemia and sepsis)