



# Comparison of Auxiliary Diagnostic Methods in Pulmonary Embolism

## Pulmoner Embolide Yardımcı Tanı Yöntemlerinin Karşılaştırılması

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### Abstract

**Aim:** We investigated the importance of auxiliary diagnostic methods in cases when computed tomography pulmonary angiography (CTPA) cannot be used in pulmonary embolism (PE) with a high mortality rate.

**Materials and Methods:** Patients were selected after the exclusion criteria were applied in a sample created from a single center. A total of 86 patients included in our study were examined in terms of clinical features, auxiliary diagnostic methods, anticoagulant use, and hospitalization and discharge status according to the massive or segmental involvement of PE in CTPA.

**Results:** The mean age of the patients was 52.29±14.14 years. According to the CTPA results, there were 46 (53.5%) patients with massive involvement and 40 (46.5%) patients with segmental involvement. While there were 38 (82.6%) patients with massive involvement whose right chambers of the heart were dilated in echocardiography (ECHO) results, there were 19 (47.5%) patients with segmental involvement. There was a statistical significance between the massive involvement of CTPA and ECHO result (p=0.001).

**Conclusion:** ECHO may be preferred as an auxiliary radiological method in the diagnosis of PE in emergency departments (ED), especially in massive embolisms.

**Keywords:** Pulmonary embolism; massive; segmental; echocardiography

### Öz

**Amaç:** Mortalite oranı yüksek pulmoner embolide (PE) bilgisayarlı tomografi pulmoner anjiyografisinin (BTPA) kullanılmadığı durumlarda yardımcı tanı yöntemlerinin önemini araştırdık.

**Materyal Metod:** Hastalar tek merkezden oluşturulan bir örnekleme dışlama kriterleri uygulandıktan sonra toplanmış oldu. Çalışmamıza dahil edilen toplam 86 hasta BTPA'da PE'nin masif ya da segmental tutulumuna göre klinik özellikleri, yardımcı tanı yöntemleri, antikoagülan kullanımı ve yatış taburculuk durumuna göre incelendi.

**Bulgular:** Hastaların yaş ortalaması 52.29±14.14 yıl idi. BTPA sonucuna göre masif tutulumu olan 46 (%53.5) ve segmental tutulumu olan toplam 40 (%46.5) hasta vardı. Masif tutulumlarda ekokardiyografi (EKO) sonucunda sağ kalp boşlukları dilate olan 38 (%82.6) hasta varken; segmental tutulumlarda ise 19 (%47.5) hasta vardı. BTPA'nin masif tutulumu ile EKO sonucu arasında istatistiksel bir anlamlılık vardı (p=0,001).

**Sonuç:** Acil servislerde PE tanısında özellikle de masif embolilerde yardımcı radyolojik yöntem olarak EKO tercih edilebilir.

**Anahtar Kelimeler:** Pulmoner emboli; masif; segmental; ekokardiyografi

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## INTRODUCTION

Acute pulmonary embolism (PE) is a common cause of acute-onset chest pain that occurs in the emergency department (ED) (1). Patients most frequently present with complaints of shortness of breath, chest pain, cough, hemoptysis, palpitation, tachypnea, and cyanosis (2). It is one of the most important causes of death in hospitalized patients and is responsible for approximately 15% of deaths. However, in case of late diagnosis or misdiagnosis, this rate can increase up to 30% (3).

Radiological methods such as chest radiography, ventilation/perfusion (V/P) scintigraphy, echocardiography (ECHO), computed tomography pulmonary angiography (CTPA), conventional pulmonary angiography, and magnetic resonance (MR) angiography are preferred for diagnosis. PE develops due to thrombosis in the deep veins of the legs in more than 3/4 of the cases (4). Color Doppler ultrasonography (CDUS) is the most commonly used imaging method in the diagnosis of DVT (5).

CT pulmonary angiography (CTPA) takes a significant place in the diagnosis of PE since it shows embolism directly and is a fast and non-invasive method (6). Furthermore, Wells scoring, which is the most preferred scoring method for PE diagnosis, is also applied (7). To date, many studies have been conducted on the relationship between the PE clinical picture and diagnostic methods (8,9).

In our study, we investigated which of the other auxiliary diagnostic methods such as posteroanterior chest X-ray (PA CXR), ECHO and lower extremity venous color doppler ultrasonography would be more helpful in diagnosing PE according to the CTPA result.

## MATERIAL AND METHOD

This study was initiated after the ethics committee approval was obtained from İnönü University Scientific Research and Publication Ethics Committee with the decision dated 05.03.2019 and numbered 2019/5-9.

### Case Selection and Data Collection

In this study, patients diagnosed with pulmonary embolism in the ED of a university hospital for a period of 1 year between 01.01.2018 and 31.12.2018 were examined. Pregnant women, patients with contrast material allergy and renal insufficiency were accepted as exclusion criteria. Patients with normal D-dimer levels (200-500 ng/ml) or D-dimer levels below normal (<200ng/ml) were not included in the study (10).

Eighty-six patients who were diagnosed with PE after the exclusion criteria were included in the study. Systemic physical examinations of the patients admitted to the ED were performed by emergency medicine specialists. Patients' age, sex, admission complaints, anticoagulant use, Wells scores, direct chest radiographs, ECHO, Doppler USG, CTPA (massive or segmental involvement), and hospitalization-discharge status were evaluated.

## Statistical Analysis

The statistical analysis of the data obtained was carried out using the IBM SPSS (version 20.0; SPSS™, Chicago, IL) program. The numerical data obtained by measurement were presented as mean and standard deviation, and the categorical data obtained by counting were presented as number (n) and percentage (%). Pearson's chi-square test was used for the statistical analysis of categorical variables, and the Mann-Whitney U test was used for the analysis of independent variables that did not exhibit normal distribution. The value of  $p < 0.05$  was considered significant in all tests.

## RESULT

Our study was conducted with a total of 86 patients, 40 (46.5%) males and 46 (53.5%) females, after all exclusion criteria were applied. The mean age of the patients was  $52.29 \pm 14.14$  years. When we examined the patients according to their complaints, we observed that the most common complaint was shortness of breath, which was followed by chest pain, cough, syncope, hemoptysis, and leg pain, respectively (Table 1).

According to the patients' CTPA results (massive and segmental involvement), sex, Wells score classifications, PA CXR results, ECHO results, the presence of DVT on Doppler USG, anticoagulant drug use, and hospitalization status were statistically compared by the chi-square test.

There were a total of 46 (53.5%) patients with massive involvement, according to the CTPA result. Of these, 22 (47.8%) were male, and 24 (52.2%) were female. Again, according to the CTPA results, 18 (45%) of 40 (46.5%) patients with segmental involvement were male, and 22 (55%) were female. No statistical significance was found between the CTPA result and sex ( $p = 0.482$ ) (Table 2).

The number of patients whose Wells score was accepted as moderate was 60 (69.8%), and the number of patients whose Wells score was accepted as high was 26 (30.2%). In massive involvement, there were 29 (63%) patients with a moderate Wells score and 17 (37%) patients with a high Wells score. In segmental involvement, there were 31 (77.5%) patients with a moderate Wells score and 9 (22.5%) patients with a high Wells score ( $p = 0.111$ ) (Table 2). On the PA CXR, the number of patients with infiltration was 59 (68.6%), the number of patients without infiltration was 14 (16.3%), and the number of patients with effusion was 13 (15.1%). In massive involvement, there were 37 (80.4%) patients with infiltration, 5 (10.9%) patients without infiltration, and 4 (8.7%) patients with effusion on the PA CXR. In segmental involvement, there were 22 (55%) patients with infiltration, 9 (22.5%) patients without infiltration, and 9 (22.5%) patients with effusion on the PA CXR ( $p = 0.039$ ) (Table 2).

While the number of patients with normal ECHO results was 29 (33.7%), the number of patients with dilated right heart chambers was 57 (66.3%). In massive involvement, there were 8 (17.4%) patients with normal ECHO results

and 38 (82.6%) patients with dilated right heart chambers. In segmental involvement, there were 21 (52.5%) patients with normal ECHO results and 19 (47.5%) patients with dilated right heart chambers ( $p=0.001$ ) (Table 2). There were 50 (58.1%) patients without DVT and 36 (41.9%) patients with DVT in Doppler USG results. In massive involvement, there were 23 (50.0%) patients without DVT and 23 (50.0%) patients with DVT on Doppler USG. In segmental involvement, there were 27 (67.5%) patients without DVT and 13 (32.5%) patients with DVT on Doppler USG ( $p=0.077$ ) (Table 2).

Among all patients, the rate of anticoagulant drug use was very low. There were only 16 (18.6%) patients using

anticoagulants. In patients with massive involvement, there were 36 (78.3%) patients not using anticoagulants and 10 (21.7%) patients using anticoagulants. In segmental involvement, there were 34 (85%) patients not using anticoagulants and 6 (15%) patients using anticoagulants. Drug use had no statistical significance for both involvements ( $p=0.423$ ) (Table 3).

The total number of patients hospitalized was 81 (94.2%), and the total number of patients discharged was 5 (5.8%). Forty-six (100%) of the patients with massive involvement were hospitalized. In segmental involvement, the number of patients hospitalized was 35 (87.5%), and the number of patients discharged was 5 (12.5%) ( $p=0.019$ ) (Table 3).

**Table 1. Complaints of the patients during admission to the ED**

Complaints	Number	Percentage
Shortness of breath	52	60.4%
Chest pain	14	16.3%
Cough	12	13.9%
Syncope	4	4.7%
Hemoptysis	3	3.5%
Leg pain	1	1.2%

**Table 2. Comparison of CTPA results with clinical variables**

CTPA Result		Massive	Segmental	Total	p-value
<b>Variables</b>					
<b>Sex</b>	Male	22(47.8%)	18 (45%)	40 (46.5%)	0.482
	Female	24 (52.2%)	22 (55%)	46 (53.5%)	
<b>Wells Scale</b>	Moderate	29 (63%)	31 (77.5%)	60 (69.8%)	0.111
	High	17 (37%)	9 (22.5%)	26 (30.2%)	
<b>PA CXR</b>	With infiltration	37 (80.4%)	22 (55%)	59 (68.6%)	0.039
	Without infiltration	5 (10.9%)	9 (22.5%)	14 (16.3%)	
<b>ECHO Result</b>	With effusion	4 (8.7%)	9 (22.5%)	13 (15.1%)	0.001
	Normal	8 (17.4%)	21 (52.5%)	29 (33.7%)	
<b>Doppler USG</b>	Dilated right heart chambers	38 (82.6%)*	19 (47.5%)	57 (66.3%)	0.077
	Without DVT	23 (50.0%)	27 (67.5%)	50 (58.1%)	
	With DVT	23 (50.0%)	13 (32.5%)	36 (41.9%)	

PA CXR: Posteroanterior chest X-ray, ECHO: Echocardiography, USG: Ultrasonography, DVT: Deep vein thrombosis

**Table 3. Comparison of the drug use and hospitalization variables according to CTPA results**

CTPA Result		Massive	Segmental	Total	p-value
<b>Drug Use Status</b>	Using anticoagulants	10 (21.7%)	6 (15%)	16 (18.6%)	0.423
	Not using anticoagulants	36 (78.3%)	34 (85%)	70 (81.4%)	
<b>Hospitalization Status</b>	Hospitalization	46 (100%)	35(87.5%)	81(94.2%)	0.019
	Discharge	0(0%)	5(12.5%)	5(5.8%)	

The mean hospitalization duration in the services was 9.62 days, and the mean hospitalization duration in intensive care units was 3.30 days. All patients with massive involvement were admitted to the service or intensive care unit. However, five patients with segmental involvement were discharged outpatient without admission to the pulmonology service. Upon examining the hospitalization duration in the intensive care unit, we observed that 16 patients with massive involvement and 26 patients with segmental involvement were never admitted to the intensive care unit.

## DISCUSSION

PE is a difficult-to-diagnose lung disease that causes about 300,000 deaths annually in the United States of America (11). It is very important to make a definitive diagnosis to prevent this fatal condition. It is difficult to diagnose PE without specific clinical and physical examination findings. Therefore, some diagnostic tests are needed. Arterial blood gas, D-dimer, biochemical markers, electrocardiography, and PA CXR contribute to the diagnosis, albeit limited, in patients with suspected PE (12).

PE is a potentially fatal disease resulting in obstruction of the lung blood flow and perfusion impairment due to an embolism (13). PE is also considered an acute complication of DVT (14). While DVT has an annual incidence of 0.1% in the general population, it has a rate of more than 1% in hospitalized patients (15). Especially in proximal DVTs, Doppler USG has a sensitivity of more than 90% and a specificity of 95%. However, DVT can be detected in approximately 30-50% of patients diagnosed with PE (16). In another study, bilateral lower extremity Doppler USG performed on patients diagnosed with PE revealed thrombus in the lower extremity in 44.4% of the cases (12). In our study, we detected DVT at a similar rate in 41.9% (n=36) of PE patients in line with the literature.

PE can be observed as mild shortness of breath and can even be asymptomatic, as well as leading to death as a result of sudden cardiac arrest (17). It has a wide clinical spectrum and can often occur with different combinations such as shortness of breath, pleuritic chest pain, respiratory failure, hypoperfusion, and hemodynamic instability (17). Hemoptysis and cough may also occur, but they are usually associated with other underlying causes (18). In our study, the most common complaint of the patients was shortness of breath, while the second most common complaint was chest pain.

The mean age of the incidence of the disease is  $69.3 \pm 16.0$  years, and there is no significant difference in terms of sex (19). However, although the sex ratios were close to each other in our study, the mean age was lower ( $52.29 \pm 14.14$  years).

ECHO, which can be applied bedside by helping to diagnose PE in ED, is now indispensable. ECHO may show right ventricular dysfunction, although it cannot prove the embolism completely (20). In the study conducted by

Mazen S et al., dilatation in the right ventricle (55%) and right ventricular dysfunction (85%) were observed in the ECHO evaluation of patients with suspected PE ( $p=0.001$ ) (21). The right ventricular dilatation was observed most commonly in the ECHO evaluation of patients in our study ( $p=0.001$ ).

Although PA CXR is not a priority for diagnosis, it can support other diagnostic methods. In a study, the most common chest radiography findings were parenchymal infiltration in 37.3% (n=22) and pleural effusion in 35.6% (n=21), but no finding was detected in 33.9% (n=20) of the patients (22). In our study, parenchymal infiltration was observed most commonly, at a rate of 68.6% (n=59), in line with the literature, on the PA CXR.

With technological advances in recent years, CTPA can directly show the thrombus in the pulmonary artery bed up to the segmental level (23). Although acute PE cannot be observed with the help of CTPA, which we prefer for definite and rapid diagnosis of PE in ED, it can show alternative diagnoses for the patient's clinical picture (24). In a study evaluating the detection of acute PE, when CTPA was compared with pulmonary angiography, which is the gold standard, it was observed that CTPA had 91% accuracy (25). In the study carried out by Erdal et al., it was reported that 68% (n=64) of the thrombus were central (main and lobar arteries), and 32% (n=30) were peripheral (segmental and subsegmental arteries) (22). Our study was quite compatible with the literature, and we detected massive embolism in 53.5% (n=46) of the patients diagnosed with PE and segmental embolism in 46.5% (n=40).

In the present study, we also compared the ECHO results according to whether PE was massive or segmental. The right heart chambers were dilated in 82.6% of patients with massive PE, while the right heart chambers were dilated in 47.5% of patients with segmental PE.

As a result of a study performed according to Wells scoring, 14.75% of the patients were evaluated as those with high probability, 52.46% as those with moderate probability, and 32.79% as those with low probability (26). In our study, there were no patients with low probability in the Wells scoring. The Wells score of most patients (69.8%) was moderate. There were more patients (63%) with moderate Wells scores in both massive and segmental involvement.

Especially the anticoagulant use status of patients also affects PE. The main goal of PE treatment after discharge is to prevent the recurrence of fatal or non-fatal venous thromboembolism (VTE) with oral anticoagulants (27). Although these agents are very effective in preventing VTE recurrence, new thromboembolic events occur at an estimated rate of 3.3% (28), while fatal PE occurs in 1.5% of patients under treatment (29). In another study conducted with 124 patients, 30 patients were diagnosed with pulmonary embolism according to the results of CTPA performed on 70 patients with moderate and high probability determined as a result of V/P scintigraphy. It



was observed that 24 (80%) of 30 patients diagnosed with PE were not using any drug for prophylaxis (30). In our study, 10 (62.5%) of 16 patients were using anticoagulants due to PE history. The remaining 6 (37.5%) patients were using anticoagulants for other reasons (atrial fibrillation-flutter, heart valve replacement, stroke, etc.). Of the total patients, only five patients died. Of these 5 patients who died, 4 did not have a history of anticoagulant use, and 1 patient was using anticoagulants due to previous PE. In light of this information in the literature (28,29), we can say that the use of oral anticoagulants significantly reduces the development of recurrent PE, especially the development of fatal PE.

In the study conducted by Baydin et al. with 102 patients, 21.6% of the cases were massive PE, and 78.4% were segmental PE. Moreover, all massive and segmental cases were hospitalized (31). In our patients, all of the patients with massive involvement (n=46) and those with segmental involvement (n=35), except for 5 patients (discharge), were hospitalized.

### Limitation of the Study

The main limiting factor is that our study does not reflect the general population due to the small number of patients included. Furthermore, the fact that it could not be carried out in a multi-centered manner is also a limiting factor.

Finally, another limitation is that pulmonary angiography, which is known as the gold standard in diagnosis, could not be performed.

### CONCLUSION

PE is a disease that is difficult to diagnose in ED. Although CTPA is most commonly used in diagnosis, we cannot use CTPA in patients with contrast material allergy and renal insufficiency and pregnant women. Among the auxiliary radiological methods in diagnosis, ECHO, which can be used as a non-invasive and bedside method with ease of application and accessibility, is now indispensable in ED, especially in the diagnosis of massive PE.

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