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Original Article

Multislice computed tomography angiography imaging findings of pathologies that may mimic pulmonary embolism

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Abstract

Aim: We aimed to detect lesions that can mimic this clinical picture, except embolism, in patients with a preliminary diagnosis of pulmonary embolism, and no embolism was detected in multislice computed tomography angiography (MDCTA) examination.
Material and Methods: Turkey Yuksek Ihtisas Hospital Radiology Department, in our CT unit; between January 2007 and July 2008, from the emergency service and other clinics; A total of 180 cases, 86 males and 94 females, mean age 55, who were referred to our clinic with the suspicion of pulmonary thromboembolism (PTE) based on history, physical examination, chest radiography, and laboratory findings, and who underwent pulmonary angiography with multislice computed tomography, were analyzed. Cases found to have pulmonary embolism were excluded from the study. Multislice computed tomography angiography examinations (Lightspeed 16, General Electric Medical Systems, Milwaukee, Wis., USA) were performed in all patients using a 16 detector Computed tomography device.
Patients who may be confused with PTE clinically in the mediastinal window; pleural effusion, pericardial effusion, and parenchyma window; Pneumonic infiltration-consolidation, mass, emphysema, presence of fibrotic structures were evaluated.
Results: CT scans were normal in 18 (12.5%) of 143 patients presented with pulmonary embolism, and no embolism was found. Interstitial fibrosis in 94 cases (65.7%), atelectasis in 53 cases (37.06%), emphysema in 53 cases (37.06%), ice glass in 38 cases (26.5%), pleural effusion in 34 cases (23.7%), consolidation in 22 cases (15.3%), Pericardial effusion was detected in 14 cases (9.7%) and a mass in the lung in 10 cases (7.6%).
Conclusion: In patients without pulmonary embolism, the group of diseases that should be considered primarily in the differential diagnosis are Interstitial Lung Disease and Chronic Obstructive Lung diseases.

Keywords: Multislice computed tomography angiography, pulmonary embolism, interstitial lung disease

INTRODUCTION

Pulmonary thromboembolism (PTE) is a disease with high morbidity and mortality, which refers to the migration of clots or clots from the systemic deep veins to the pulmonary vascular bed (1,2). About 2/3 of the patients who have undergone, and survived PTE cannot be diagnosed. Diagnosis is delayed in a short time because common symptoms such as dyspnea, tachypnea, tachycardia, chest pain, cough, pleuritic flank pain, hemoptysis, and physical examination findings are not specific to this disease (3,4). The mortality rate in these patients reaches 30%. This clinical entity, which can be confused with many diseases, decreases below 10% when other diseases are eliminated quickly and accurately, and appropriate treatment is performed (1). Today, Multislice Computed Tomography

Angiography (MSCTA) has come to the forefront because of its advantage in providing information about pleura, parenchyma, and mediastinal pathologies, enabling us to quickly diagnose embolism (4,5).

In this study, we aimed to detect lesions that may mimic this clinical picture, except for embolism, in patients with a pre-diagnosis of pulmonary embolism and no embolism in MSCTA.

MATERIAL AND METHODS

Turkey Yuksek Ihtisas Hospital Radiology Department in our CT unit; Between January 2007 and July 2008, from the emergency service and other clinics; 180 cases who were referred to our clinic with suspicion of PTE based on history, physical examination, chest X-ray, and laboratory findings and who underwent Pulmonary Angiography (PCTA) with Multislice Computed Tomography (MCT) were analyzed. Of the patients, 86 were male, and 94 were female, with a mean age of 55 (91-16).

Age, history of surgical operation, and additional signs of cardiac failure were recorded for all patients.

All MSCTPA examinations (Lightspeed 16, General Electric Medical Systems, Milwaukee, Wis., USA) were performed with a multislice CT device, and contrast agent injection was performed using a Medrad brand CT auto-injector system (6).

The examination area from the diaphragm to the aortic arch was determined on the scanogram (topogram) taken while lying in the supine position in all cases. In the examinations, 120-150 ml (1-2 ml/kg) non-ionic contrast agent (350mg/ml) was administered at a rate of 4 ml/s by an automatic injector through the vascular access opened with an 18-gauge intraket in the antecubital vein in the supine position. After considering the cardiac performance status of the patient, the examination was started then the superior vena cava density reached 100HU with the bolus method (Smart-prep, GE Healthcare) with a section thickness of 2.5mm. Cross-sectional images were obtained using 120kV, 180-250mA, with parameters determined as 1.25 mm tube rotation speed 500msec and wide FOV. All CTPA examinations were performed caudocranially and in a single breath-hold period (7-9).

The resulting images were transferred to the workstation (Advantage Workstation, AW 4.2, GE Medical Systems) for analysis. All cross-sectional images transferred to the workstation were evaluated by two radiologists, one of whom is a specialist and the other with four years of experience in radiology, in terms of the presence of occlusive or non-occlusive embolism in the main, lobar, and segmental arteries, the adequacy of vascular contrast enhancement, mediastinal and parenchymal pathologies. Axial images were viewed with standard mediastinal (level 50 HU; width 350 HU) and lung parenchyma window settings (level -600 HU; width 1600 HU) (10,11). In cases where there was disagreement among the radiologists, a joint evaluation was made by coming together, and the final evaluation made by the two radiologists was taken as a basis.

In the mediastinal window, which can be confused with PTE clinically by both evaluators, pleural effusion, pericardial effusion, and in the parenchyma window; Pneumonic infiltration - consolidation, nodule, mass, emphysema, presence of fibrotic structures were determined. In addition, ground glass infiltration, atelectasis, peripheral triangle-shaped increased density, and vascular signs that can be seen in the presence of PTE were investigated (12,13).

Pulmonary trunk, right and left pulmonary artery widths in all cases were measured with an electronic marker in the mediastinal window and recorded in the patient data form. Pulmonary trunk measurements were measured from the widest level within 3 cm of the bifurcation, right pulmonary artery measurements were measured from the sections that were like the continuation of the pulmonary trunk, and left pulmonary artery measurements were measured from the sections where the pulmonary vein was observed, perpendicular to the long axis of the vessel (5,14).

The images obtained in the mediastinal window settings of the MSCTPAs of the patients were evaluated in terms of the presence or absence of intraluminal filling defects in the pulmonary arteries presence or absence of pulmonary effusion (2,15,16).

Parenchymal abnormalities examined in parenchymal window settings; emphysema (increased aeration), atelectasis (loss of volume), consolidation (non-wedge-shaped bright area that hides bronchovascular signs), ground-glass appearance (parenchymal shadow that does not obscure bronchovascular signs), interstitial fibrosis (structures in the form of thin bright lines or bands), ascending aortic aneurysm (diameter exceeding 40mm in measurements made in the widest part of the ascending aorta), aortic aneurysm in the arcus (cases in diameter exceeding 30mm in measurements made in the widest part of the aortic aorta), descending aortic aneurysm (diameter exceeding 30mm in measurements made in the widest part of the aortic arch) cases exceeding (4,17,18).

The presence of any parenchymal abnormality mentioned above and the number of cases in total was recorded in cases with and without PE.

RESULT

A total of 180 cases, 86 male (47.7%) and 94 female (52.2%), aged between 16 and 91 years (mean age: 55 years) who were referred to our clinic with the preliminary diagnosis of pulmonary embolism were evaluated. In the cases, the diagnosis of pulmonary thromboembolism (PTE) was made with the joint decision of the two evaluators, who saw a filling defect in the pulmonary artery in MCPBTA. In 11 (6.1%) of these cases, vascular enhancement, which could lead to a misconception in the diagnosis of PTE, was not optimal, and in 4 (2.2%) cases, it could not be evaluated optimally due to intense motion artifacts.

PTE was detected in 37 (20.5%) of 180 cases included in the study, and PTE was not found in 143 (79.4%) cases. At least one parenchymal abnormality was found in 37 of 37 patients with pulmonary embolism and in 125 of 143 patients without

pulmonary embolism.

The most common parenchymal finding was interstitial fibrosis in cases with or without PTE. In cases without PTE, emphysema, atelectasis, ground-glass appearance, pleural effusion, and consolidation were followed, respectively. Pericardial effusion, thoracic aortic aneurysm, and mass were seen much less frequently (4,19).

The most common parenchymal findings in patients without pulmonary embolism are summarized in Figure 1

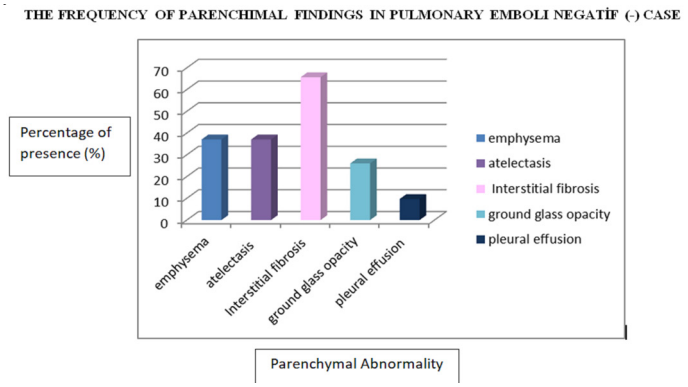


Figure 1. The frequency of parenchımal fındıngs ın pulmonary emboli negatif (-) case

Eighteen (12.5%) of 143 patients presented with pulmonary embolism, and no PTE had normal tomography. Interstitial fibrosis in 94 (65.7%) cases, atelectasis in 53 cases (37.06%), emphysema in 53 cases (37.06%), ground-glass opacity in 38 cases (26.5%), pleural effusion in 34 cases (23.7%), consolidation in 22 cases (15.3%), Pericardial effusion in 14 cases (9.7%), ascending aortic aneurysm in 12 cases (8.3%), aneurysm in the aortic arch in 11 cases (7.6%), mass in the lung in 10 cases (7.6%), and aneurysm in the descending aorta in 9 cases (6.9%).

The frequency of parenchymal findings in patients with and without pulmonary embolism is summarized in Table 1.

Table 1. Frequency of parenchymal findings in patients with or without pulmonary embolism

	PTE (-)		PTE (+)	
ate	number	percent	number	percent
Normal	18	12.5%	0	0.0%
Emphysema	53	37.06%	18	48.6%
Atelectasis	53	37.06%	17	45.9%
Consolidation	22	15.3%	8	21.6%
Pleural effusion	34	23.7%	11	29.7%
Frosted glass	38	26.5%	20	54.05%
Interstitial fibrosis	94	65.7%	32	86.4%
AC operation	0	0.0%	0	0.0%
Pericardial effusion	14	9.7%	4	11.4%
Ascending aortic aneurysm	12	8.3%	4	11.4%
Arch aortic aneurysm	11	7.6%	7	18.9%
Dessenden aortic aneurysm	9	6.9%	7	18.9%
AC mass	10	7.6%	1	2.7%

There was no significant relationship between the probability of having PTE and the frequency of parenchymal findings. However, in cases without PTE, the most common parenchymal finding was interstitial fibrosis, which may also manifest interstitial lung disease. Interstitial fibrosis was detected in 94 patients who did not have PE. Of these patients, 23 (24.4%) had lung infection, 17 (18%) cardiac findings, 6 (6.3%) masses, 1 (1.06%) Pneumothorax (20,21). Interstitial fibrosis was common in those with pulmonary infection and underlying cardiac disease.

The relationship of interstitial fibrosis in cases without pulmonary embolism and underlying diseases are summarized in Table 2.

Table 2. The relationship between interstitial fibrosis and underlying diseases in patients without Pulmonary Embolism

	PTE (-)	
Interstitial fibrosis	**n**	**%**
Lung infection	23	24.4
Cardiac disease	17	18
Mass	6	6.3
Pneumothorax	1	1.06

Atelectasis was found in 53 cases in which no pulmonary embolism was detected. In 15 (28.3%) of these patients, external compression with cardiac pathologies, lung infection in 6 (11.3%), mass in 5 (9.4%), pneumothorax in 1 (1.8%), and mucus plug in 1 (1.8%) were detected (22). Atelectasis can be observed for obstructive or non-obstructive reasons. Atelectasis is frequently observed in patients with cardiac pathologies and masses.

The relationship between atelectasis and underlying diseases in patients without pulmonary embolism is summarized in Table 3.

Table 3. Relationship between atelectasis and underlying diseases in cases without Pulmonary Embolism

	PTE (-)	
Atelectasis	**n**	**%**
External pressure for cardiac reasons	15	28.3
Lung infection	6	11.3
Mass	5	9.4
Pneumothorax	1	1.8
Mucus plug	1	1.8

A frosted glass appearance was observed in 38 patients who presented with a preliminary diagnosis of pulmonary embolism, and no embolism was detected. Pulmonary edema was found in 17 (44.7%) of these patients, lung infection in 5 (13.1%), and bronchial cancer in 2 (5.2%) patients. No pathology was found in the CT of 14 patients (36.8%). It is a non-specific finding and can be observed in many unrelated diseases. In our study, the frosted glass appearance was most frequently observed with pulmonary

edema and lung infection (22).

The relationship between frosted glass appearance and underlying diseases in cases without PE is summarized in Table 4.

Table 4. The relationship between the frosted glass appearance and the underlying diseases in cases without pulmonary embolism

	PTE (-)	
Frosted glass appearance	**n**	**%**
AC edema	17	44.7
AC infection	5	13.1
Mass	2	5.2

Pleural effusion was observed in 34 cases in whom pulmonary embolism was not detected. Congestive heart failure in 13 (38.2%) of these patients, pneumonia in 10 (29.4%), cardiac operation in 6 (17.6%), mass in 3 (8.8%), viral diseases in 2 (5.8%) detected. Pleural effusion was most frequently detected in patients with congestive heart failure and lung infection (21).

The relationship between pleural effusion and underlying diseases in patients without pulmonary embolism is summarized in Table 5.

Table 5. The relationship of pleural effusion with underlying diseases in patients without pulmonary embolism

	PTE (-)	
Pleural Effusion	**n**	**%**
Congestive heart failure	13	38.2
Ac infection	10	29.4
Operation	6	17.6
Mass	3	8.8

Consolidation was observed in 22 patients in whom pulmonary embolism was not detected. Mass in 2 (9%) patients, pulmonary edema in 6 (27%), atelectasis in 2 (9%) and pneumonia in 12 (54.5%) patients (13). Consolidation was most frequently seen with a lung infection.

The relationship between consolidation and underlying diseases in patients without pulmonary embolism is summarized in Table 6.

Table 6. The relationship of consolidation with underlying diseases in cases without pulmonary embolism

	PTE (-)	
Consolidation	**n**	**%**
Mass	2	9
Ac edema	6	27
Athelectasis	2	9
Pneumonia	12	54.5

Pericardial effusion, one of the most frequently confused clinical entities with pulmonary embolism clinic, was detected in 14 cases without embolism. Underlying cardiac diseases were found in 5 (35.7%) and mass lesions in 2 (14.2%) (13,23). Although there was no parenchymal finding besides pericardial effusion in the remaining seven patients (50%), it imitated embolism alone.

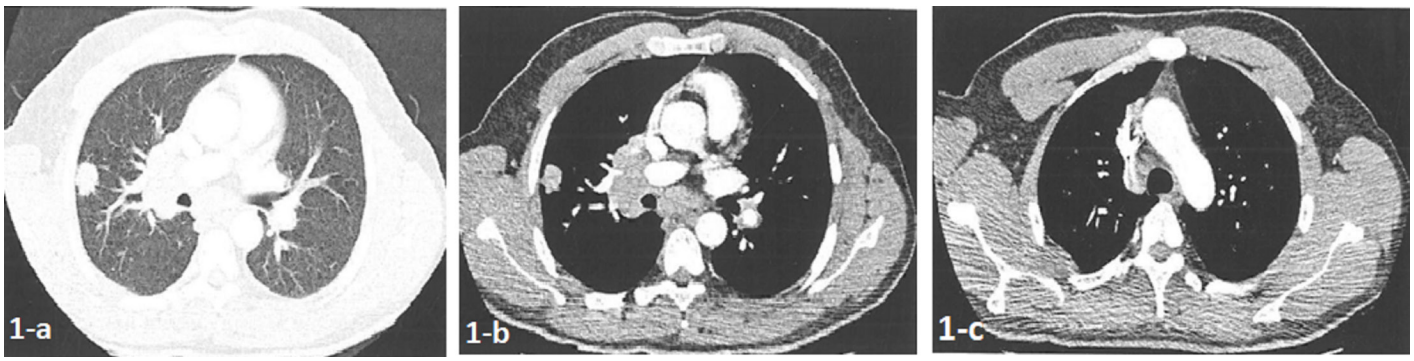
The relationship between pericardial effusion and underlying diseases in patients without pulmonary embolism is summarized in Table 7.

Table 7. The relationship of pericardial effusion with underlying diseases in cases without pulmonary embolism

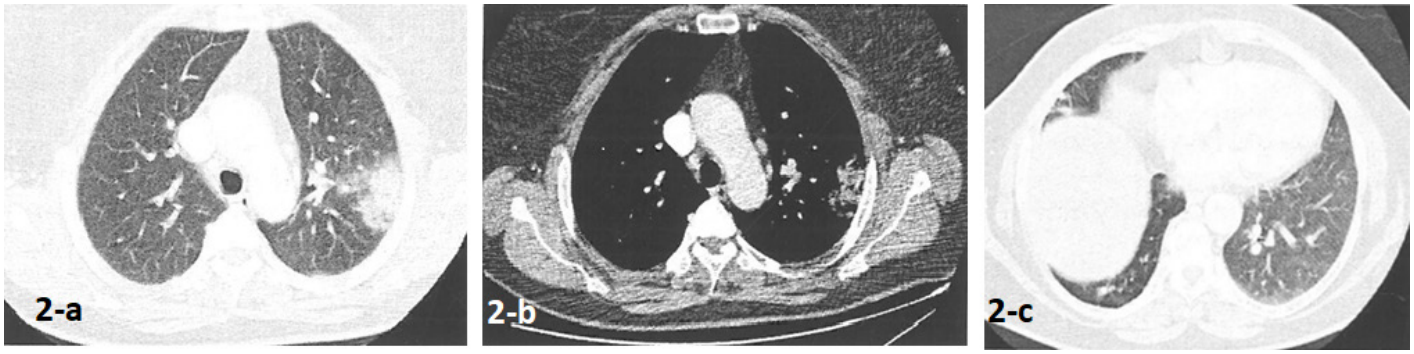
	PTE (-)	
Pericardial effusion	n	%
Heart disease	5	35.7
Mass	2	14.2

CASE EXAMPLES

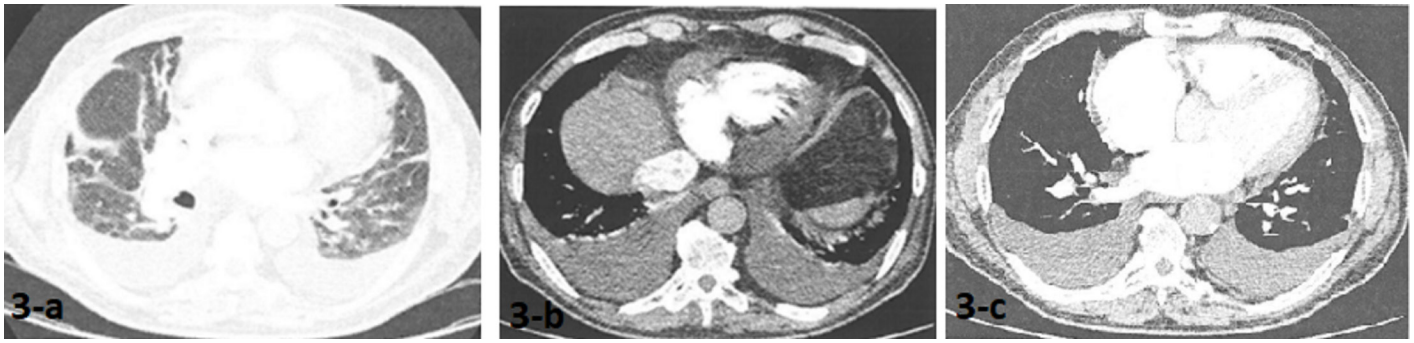
Case 1: 43-year-old male patient on axial CT sections; (a) A mass lesion of soft tissue density with a spiculated contour in the right lung middle lobe lateral segment in the parenchymal window. (b) A mass lesion of soft tissue density with spiculated contours in the lateral segment of the right lung middle lobe in the mediastinal window and subcarinal, hilar multiple conglomerated lymph nodes. (c) Several paratracheal lymphadenopathy in the mediastinal.



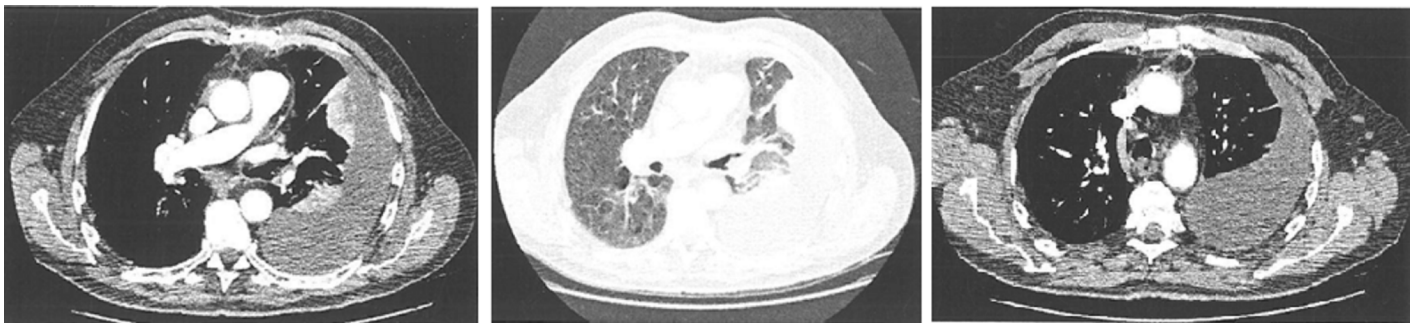
Case 2: Axial CT scans of a 32-year-old female patient. (a) Consolidation area in the left lung upper lobe apicoposterior segment in the parenchymal window and a slight ground glass area around it. (b) Consolidation area in the left lung upper lobe apicoposterior segment in the mediastinal window and several lymph nodes in the prevascular area. (c) Ground-glass area of the lower zone of the left lung in the parenchymal window.



Case 3: Axial CT scans of a 68-year-old male patient. (a) Linear opacities and bilateral pleural effusion in both lung lower lobe posterobasal segments in the parenchymal window. (b) Bilateral pleural effusion in the mediastinal window and adjacent linear compression atelectasis. (c) Bilateral pleural effusion in the mediastinal window and linear compression atelectasis adjacent to the right and left ventricles.



Case 4: A 55-year-old male patient on axial CT scans. (a) Pleural effusion in the left hemithorax in the mediastinal window, compression atelectasis adjacent to the effusion. (b) Ground-glass appearance in the lower zones of both lungs in the parenchymal window and pleural effusion in the left lung. (c) Pleural effusion and paratracheal millimetric lymph nodes in the left hemithorax in the mediastinal window.



DISCUSSION

MSCTPA accelerated the diagnosis process in patients with suspected pulmonary embolism by reducing it to a single breath-hold period (7,8,24). Today, MCBTA has become the first preferred diagnostic method because it is non-invasive as well as provides information about concomitant parenchymal findings and intrathoracic formations, as well as being fast (6,24,25). However, in routine practice, the focus is more on the presence or absence of PE in MCBTA. There are many studies dealing with the prevalence of parenchymal and pleural findings in cases with PE, but as far as we know, there are not many studies dealing with concomitant parenchymal findings in cases with no embolism.

Pulmonary embolism is a disease with high mortality if not diagnosed early. Its clinical findings are diverse and can mimic many diseases (1,3). In this study, we tried to determine the parenchymal findings of the patients who applied to our clinic with a preliminary diagnosis of pulmonary embolism and underwent PCTA in cases without embolism.

It is possible not to detect various parenchymal findings secondary to underlying diseases in cases without pulmonary embolism (17). In this study, at least one parenchymal abnormality was found in 100% of patients with PE and in 87.4% of patients without PE. The findings were compared with the findings of the studies published previously (Table 8).

Table 8. Comparison of studies evaluating pleural and parenchymal findings on computed tomography of patients without pulmonary embolism

Study	Collimation	Number of patients without PE	Any parenchymal abnormality	Atelectasis	Ground glass opacity	Consolidation	Linear opacity
Available study	2,5 mm	143 (%79.4)	125 (%87.4)	53 (%37)	38 (%26.5)	22 (%15.3)	94 (%65.7)
Coche et al.	3 mm	62 (%70.4)	N	17 (%27)	N	15 (%24)	13 (%21)
Shah et al.	3mm,5mm	64 (%69.5)	56 (%88)	41 (%64)	16 (%25)	14 (%22)	25 (%29)
Ozer et al.	3mm	71 (%70.3)	48 (%67.6)	16 (%22.5)	16 (%21.1)	19 (%26.7)	N
Total		340	229/278 (%82.3)	127 (%37.3)	69/278 (%24.8)	70 (%20.5)	132/269 (%49)

PE :Pulmonary Embolism, N: Not reported

In the study of Coche et al., with 88 people, the most common parenchymal abnormality detected in 62 cases without embolism was pleural effusion with a rate of 42% and atelectasis with a rate of 27%. Other findings were reported as consolidation with 24% and linear opacity with 21%, respectively (12).

In the study of Shah et al. with 92 people, the most common parenchymal abnormality was atelectasis with 64%, pleural effusion with the rate of 56%, linear opacity with 39%, and frosted glass appearance with 25%, respectively, in 64 cases without embolism. Consolidation has been reported as a mass of 3% (13).

In the study conducted by Özer et al. with 101 people, the most common parenchymal abnormality in 71 cases without embolism was reported as pleural effusion with a rate of 46.4%; the second most common finding was consolidation with 26.7%, followed by atelectasis with 22.5% and frosted glass appearance with 21.1%, respectively (23).

In our study, linear opacity, a sign of interstitial fibrosis, was found to be the most common parenchymal abnormality in 65.7%. Of the 94 emboli-negative patients with linear opacity, 23 (24.4%) had lung infection, 17 (18%) cardiac findings, 6 (6.3%) masses, and 1 (1.06%) pneumothorax. No pathological finding was detected in 47 patients (50%) on CT.

In our study, atelectasis was found to be the second most common parenchymal abnormality with 37.6%. Pulmonary atelectasis is a common alternative diagnosis in patients undergoing CTPA with a pre-diagnosis of PTE (20).

In our study, atelectasis was found in 53 patients with negative emboli, 15 (28.3%) external compression, 6 (11.3%) lung infection, 5 (9.4%) mass, 1 (1.8%) pneumothorax, 1 (1.8%) mucus plug has been detected. In the remaining 25 patients (47.1%), no obvious pathology was detected on CT.

In our study, ground-glass opacity was determined as the second most common parenchymal finding, and this rate was recorded as 26.5%. In cases without pulmonary embolism, the reason for the ground-glass opacity may be due to partial filling of the alveoli with fluid or cells or early atelectasis. In our study, of 38 embolism-negative patients with frosted glass appearance, 17

(44.7%) pulmonary edema, 5 (13.1%) lung infection, 2 (5.2%) bronchial cancer was detected. No pathology was found in the CT of 14 patients (36.8%).

In our study, consolidation was also among the most common parenchymal abnormalities, with a rate of 15.3%. In our study group, out of 22 patients without pulmonary embolism, mass was found in 2 (9%), pulmonary edema in 6 (27%), atelectasis in 2 (9%), pneumonia in 12 (54.5%).

Pleural effusion may occur due to various lung diseases and systemic diseases. In our study, pleural effusion was detected in 34 (23.7%) of the cases in which no embolism was detected. The most frequent causes of pleural effusion are congestive heart failure, pneumonia, and cancer. In our study, out of 34 patients with pleural effusion, 13 (38.2%) had congestive heart failure, 10 (29.4%) pneumonia, 6 (17.6%) cardiac operation, 3 (8.8%) mass, 2 (5.8%) viral diseases were detected.

Parenchymal abnormalities such as a mass are extremely rare. In our study, a mass was found in 10 (7.6%) of 143 patients without embolism. Among other studies evaluating the pleural and parenchymal findings on MSCTs of patients without pulmonary embolism, only Shah et al. (13) investigated the presence of a mass, and this rate was found to be 3% with two patients. The higher percentage of mass in our results may be related to the different CT devices and CT acquisition techniques (such as fine collimation).

CONCLUSION

In conclusion, we believe that most of the patients who were referred to our clinic with a pre-diagnosis of PE and undergone MSCT have pleuroparenchymal abnormalities (17). Pulmonary embolism clinical can be confused with many diseases, and many patients receive unnecessary treatment despite the absence of PE (26). Today, in patients with suspected PE and who can hold their breath, MSCTA is an increasingly important method in the diagnosis of pulmonary embolism since it directly shows emboli and provides additional information about the mediastinum and lung parenchymal, as well as vascular structures (19,26). Interstitial Lung Disease and Chronic Obstructive Pulmonary (COPD) Diseases are the group of diseases that should be considered primarily in the differential diagnosis in patients who do not have a pulmonary embolism.

Conflict of interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical approval
Ethics committee approval was received from Ankara Turkey Yüksek İhtisas Hospital / 2009.

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