Original Article

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The Diagnostic Accuracy of the Hounsfield Unit Value in Pulmonary Embolism

Hounsfield Unit Density Value in Pulmonary Embolism

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ABSTRACT

Objective: Pulmonary embolism (PE) a vascular disease. Computed tomography pulmonary angiography (CTPA) is the radiological imaging technique used to diagnose PE. In this study, we aimed to demonstrate the diagnostic accuracy of Hounsfield Unit (HU) value for PE based on the hypothesis that acute thrombosis causes an increase in HU value on computed tomography (CT). Methods: This research was as a single-center, retrospective study. Patients presenting to the emergency department (ED) diagnosed with PE on CTPA were enrolled as the study group. In addition, patients admitted to the same emergency department who were not diagnosed with PE and had non-contrast CT scans were included as the control group. A receiver operating curve (ROC) was produced to the diagnostic accuracy of HU values in predicting PE. Results: The study population (N=74) consisted of a study group (N=46) and a control group (N=28). The sensitivity and specificity of HU value for predicting PE on thoracic CT were found 61.5% and 96.4% at a value of 54.8 (Area Under the Curve (AUC):0.690) for right main pulmonary artery; 65.0% and 96.4% at a value of 55.9 (AUC:0.736) for left main pulmonary artery; 44.4% and 96.4% at a value of 62.7 (AUC:0.615) for right interlobar artery; and 60.0% and 92.9% at a value of 56.7 (AUC:0.736) for left interlobar artery. Conclusion: HU values may exhibit high diagnostic specificity on CT, for thrombi up to the interlobar level. An HU value exceeding 54.8 up to the interlobar level may raise suspicion of the presence of PE.

Keywords: Hounsfield unit, pulmonary embolism, non-contrast thorax CT, Hounsfield unit density

Capsule Summary

What is already known

Pulmonary embolism (PE) is often diagnosed in the emergency department (ED). Pulmonary angiography (PA) is the gold standard for diagnosis. However, computed tomography pulmonary angiography (CTPA), chest magnetic resonance imaging (MRI), chest X-ray, echocardiography, limb ultrasonography, and nuclear medicine imaging modalities are also used for diagnosis. CTPA is the most frequently used radiological imaging in clinical practice to diagnose PE. An intravenous contrast agent is used for CTPA. In cases of contrast allergy, severe renal insufficiency, alternative diagnostic tools are needed.

What is new in the current study

We know that HU density values can be used in many diseases at radiological diagnosis. In our study, non-contrast thoracic CT may exhibit high diagnostic specificity with HU density values, especially for thrombi up to the interlobar level.

INTRODUCTION

Pulmonary embolism (PE), a vascular disease with heightened morbidity and mortality, is often diagnosed in the emergency department (ED). PE is a difficult diagnosis for clinicians, since no characteristic physical examination sign or symptom exists [1]. Pulmonary angiography (PA) is the gold standard for diagnosis. However, computed tomography pulmonary angiography (CTPA), chest magnetic resonance imaging (MRI), chest X-ray, echocardiography, limb ultrasonography, and nuclear medicine imaging modalities are also used for diagnosis [2,3].

CTPA is the most frequently used radiological imaging in clinical practice to diagnose PE [4-6]. An intravenous contrast agent is used for CTPA. In cases of contrast allergy, severe renal insufficiency, and pregnancy, computed tomography (CT) imaging can be performed without intravenous contrast to establish the diagnosis by indirect methods [7].

The Hounsfield unit (HU) is a relative quantitative measurement of radio density used by radiologists to interpret CT images. The linear transformation of radio density creates a HU scale that shows gray tones. More dense tissue, with better X-ray beam absorption, has positive values and appears bright; less dense tissue, with weaker X-ray beam absorption, has negative values and appears dark [8]. Using HU helps radiologists interpret images and diagnose diseases [9-12].

The CT attenuation of whole blood and its parts has been studied [13,14]. Increases in clotted blood hematocrit cause a proportional increase in density measured in HU. Therefore, acute thrombosis usually has a HU of 60-80 [13].

Previous studies have examined the diagnostic accuracy of HU values on CT for cranial venous thrombosis and deep vein thrombosis (DVT) [10,15]. In this study, we aimed to demonstrate the diagnostic accuracy of HU value for PE based on the hypothesis that acute thrombosis causes an increase in HU value on CT.

METHODS

Study Population and Design

This research was conducted as a single-center, retrospective study. Approval from the local ethics committee (decision no. 2023/84) was obtained before data scanning.

Patients presenting to the ED of a tertiary training and research hospital in Turkey between January 1 and December 31, 2021, and diagnosed with PE on CTPA were included in the study group. The control group included patients presenting to the same ED between September 1 and October 1, 2022, not diagnosed with PE based on clinical and laboratory findings, who had non-contrast thorax CT imaging, and with no prior history of PE.

All patients not meeting the exclusion criteria were included in the study. Patients under 18 years of age, pregnant women, patients with a history of hematological malignancy, with bleeding findings, with histories of severe anemia (Hemoglobin levels < 8 g/dL), with CTPA and non-contrast thoracic CT images not suitable for measurements due to the presence of artifacts, and patients who died in the ED were excluded from both the study group and the control group. In addition, patients with clinically suspected PE but incomplete CTPA imaging and patients in whom CTPA did not diagnose PE were excluded from the study group. Following application of the inclusion and exclusion criteria, a study population (N=74) was established consisting of a study group (N:46) and a control group (N=28). The patient flow chart is shown in **Figure 1.**

Study Protocol

The study population was formed after the exclusion criteria were applied to the study and control groups. All data of the patients were obtained from the hospital's digital archive. It was planned to examine the demographic data, comorbidities, admission symptoms, hematocrit index, and non-contrast thorax CT and CTPA findings included in the study (study and control group).

CTPA and non-contrast Thoracic CT findings were recorded at the initial presentation, and both imaging modalities were evaluated by separate radiologists (one radiologist for each group). The radiologists evaluating the images had three years of experience in cardiothoracic CT imaging. Radiologists were unaware of demographic data, comorbidities, presenting symptoms, and hematocrit index. Nevertheless, the radiologist who performed the CTPA evaluation was not blinded to the diagnosis of PE because they saw contrast transmission. And also, radiologists were blind to each other's assessments.

Measurements

All the patients' CT scans were obtained with a 16-slice multidetector CT scanner (Toshiba Alexion™; Toshiba Medical Systems Corporation, Nashua, Japanese) with 1 mm thick slices and 120 kVp. The radiologist independently evaluated the CT scans using the hospital's digital archive picture archiving and communication system (PACS). Images with artifacts that could impact the measurement values were eliminated from the assessment. Acute embolism was defined as a clot in the pulmonary arteries on CT pulmonary angiograms. For this definition, it refers to areas where there is no contrast pass-through. All measurements in the study and control group were made from areas without contrast passage.

In cases of PE with no contrast passage in the pulmonary arteries in contrast-enhanced CT, the HU values were measured by selecting the area with the most extensive filling defect for the region of interest (ROI). In the same way, similar-sized ROIs were used to obtain measurements from comparable levels in non-contrast CT images of patients with no prior PE. For standardization of measurements, ROI size of 0.5 cm2 was used for the main pulmonary artery (MPA), right main pulmonary artery (RMPA), and left main pulmonary artery (LMPA); ROI size of 0.3 cm2 was used for the right interlobar artery (RILA), and left interlobar artery (LILA); ROI size of 0.05 cm2 was used for the right upper lobe segmentary branch (RULSB), right middle lobe segmentary branch (RMLSB), right lower lobe segmentary branch (RLLSB), left upper lobe segmentary branch (LULSB) and left lower segmentary branch (LLLSB).

In the study group (PE group), contrast-enhanced thorax CT HU value measurements were performed from the area (thought to be a thrombus) without contrast passage. HU value measurements were determined by standardized ROI size immediately distal to the area without contrast passage. Likewise, In the control group (non-PE group), non-contrast thorax CT HU value measurements were performed starting from the main pulmonary artery to the distal segmental branches. HU value measurements were determined by standardized ROI size. The determined HU value was recorded. In measurements planned in this way, non-contrast field measurements on contrast-enhanced CT will likely include HU values of thrombus areas (which may also be normal). In contrast, the non-contrast area measurements on non-contrast CT are considered to include HU values of regular areas.

The measurements of CT scans are shown in **Figure 2 and Figure 3.**

Endpoints

The end point of this study is the diagnostic accuracy of HU value for PE on thorax CT.

Statistical Analysis

All statistical analyses were performed on Jamovi v.1.6 software (Jamovi Project Computer Software, version 1.6. Sydney, Australia). Type 1 errors were accepted as 5% for all comparisons. The Shapiro-Wilk test was applied to evaluate whether the data were normally distributed. Continuous variables were expressed as mean and standard deviation (SD) (minimum-maximum) if they followed a normal distribution. Continuous variables were expressed as median and interquartile range (IQR) if they did not follow a normal distribution. The categorical data were represented as the frequency (n) and percentage (%). In comparing the continuous variables, groups with normal distribution were compared with the t-test, and those lacking such a distribution were compared with the Mann-Whitney U test. The Chi-squared test was used to compare the categorical variables between groups. A receiver operating curve (ROC) was produced to determine the cut-off levels of the right main pulmonary artery, left main pulmonary artery, right interlobar artery, and left interlobar artery HU value for PE. Youden's index (maximum value) in ROC analysis was used to select the cut-off value. Finally, sensitivity, specificity, likelihood ratios (+LR and -LR), and positive and negative predictive values were calculated for the right main pulmonary artery, left main pulmonary artery, right interlobar artery, and left interlobar artery HU value.

RESULTS

The study population included 74 patients, which fulfilled the inclusion and exclusion criteria: 46 (62.2%) in the study group and 28 (37.8%) in the control group. Among the patients, 29 (39.2%) were men, and 45 (60.8%) were women. The median age of the patients was 74 (IQR 66-81). The patients in the study were similar in age and gender distribution in the two groups. The most common comorbid diseases were hypertension (70.3%) and stroke 1 (20.3%), and the most common admission symptoms at the ED were dyspnea (32.4%) and chest pain (21.6%). The mean hematocrit of the patients was 38.5,

with a minimum score of 25.4 and a maximum one of 54.0. The patients in the two groups had a similar hematocrit value. The patient's demographic data, admission symptoms, and hematocrit values are shown in **Table 1.**

In contrast-enhanced CT, HU value measurements were made in RMPA 19, LMPA 20, RILA 18, LILA 16, RULSB 5, RMLSB 6, RLLSB 4, LULSB 5 and LLLSB 4 from the area without contrast transmission. Since there was no area without contrast passage in MPA, MPA HU value measurement could not be performed on contrast-enhanced CT. Similarly, HU was measured in all segments (28) on non-contrast CT. The mean HU values of non-contrast areas (thought to be a thrombus) measured in the study group and the mean HU values of non-contrast areas measured in the control group included a statistically significant difference at RMPA, LMPA, RILA, and LILA levels (p=0.006 for RMPA, p=0.005 for LMPA, p=0.034 for RILA, p=0.014 for LILA). In addition, there was a statistically significant difference in the mean HU value/hematocrit ratio in RMPA, LMPA, RILA, and LILA levels between the study and control groups (p=0.006 for RMPA, p=0.007 for LMPA, p=0.047 for RILA, p=0.003 for LILA). The summary statistics of HU values and HU values/hematocrit ratio between the study and control groups are shown in **Table 2.**

The RMPA, LMPA, RILA, and LILA cut-off HU values were calculated to predict PE. The Area Under the Curve (AUC) value for RMPA HU was 0.690 (95% confidence interval; 0.457-0.922, p=0.005), and the cut-off value for RMPA HU was 54.8, exhibiting 61.5% sensitivity and 96.4% specificity. The AUC value for LMPA HU was 0.736 (95% confidence interval; 0.563-0.909, p=0.001), and the cut-off value for LMPA HU was 55.9, exhibiting 65.0% sensitivity and 96.4% specificity. The AUC value for RILA HU was 0.615 (95% confidence interval; 0.364-0.866, p=0.030), and the cut-off value for RILA HU was 62.7, exhibiting 44.4% sensitivity and 96.4% specificity. The AUC value for LILA HU was 0.736 (95% confidence interval; 0.475-0.996, p=0.009), and the cut-off value for LILA HU was 56.7, exhibiting 60.0% sensitivity and 92.9% specificity. The cut-off values of RMPA, LMPA, RILA, and LILA HU value for PE a receiver operating curve (ROC) analysis are shown in **Table 3** and **Figure 4**.

DISCUSSION

The present study found that there were statistically significant differences in HU values at the RMPA, LMPA, RILA, and LILA levels. Between the study and control groups, there were statistically significant differences in HU values at the RMPA level (57.6-41.7, p=0.006), the LMPA level (62.0-47.2, p=0.005), the RILA level (58.2-47.7, p=0. 034), and the LILA level (58.3-44.7, p=0. 014). However, there was no statistically significant difference in HU values between both groups at the RULSB, RMLSB, RLLSB, LULSB, and LLLSB levels. In line with our data, we can say that the mean HU values of non-contrast areas (thought to be a thrombus) measured in the study group and the mean HU values of non-contrast areas measured in the control group included a statistically significant difference up to the level of the interlobar branch. Another conclusion is that pulmonary thrombus may cause an increase in HU value, which was seen in other thrombus studies [10,15].

In a previous study Besachio et al. examined the value of HU on non-contrast CT in diagnosing cerebral venous thrombosis. They found that when HU threshold values greater than 65 and a HU to hematocrit ratio greater than 1.7 were applied alone or in combination, most cases of venous thrombosis could be identified on a non-contrast head CT. The study concluded that absolute HU values and the HU to hematocrit ratio might be helpful in the non-contrast head CT evaluation of cerebral venous thrombosis [16]. Again, Kim et al. also evaluated the HU value of deep femoral vein thrombosis before and after contrast for PE prediction. In a study of 94 patients, the HU value in the DVT-PE group was 53.5 before contrast and 67 after ($p< 0.001$). In contrast, the HU value in the DVT alone group was 44.1 before contrast and 57.1 after ($p< 0.001$). The study concluded that HU value intensity on pre- and post-contrast CT may be a predictive factor for PE [15].

Jung et al. investigated the value of the DVT HU value in predicting PE on lower extremity venous CT. In ROC analysis, the AUC for the cut-off value of 63.0 for HU value was 0.737; sensitivity was 72.2%, and specificity was 66.7%. As a result, the study concluded that high HU value at a lower extremity venous CT may be predictive for PE [17]. In the study by Alharbi et al., the HU value and HU value/hematocrit ratio were evaluated in acute cerebral venous sinus thrombus. The HU value of 56 was found to have 100% sensitivity and specificity in the diagnosis. The HU/hematocrit ratio of 1.48 was found to have 100% sensitivity and 65% specificity; the HU/hematocrit ratio of 1.77 was found to have 85% sensitivity and 90% specificity, and the HU/hematocrit ratio of 1.88 was found to have 79%

sensitivity and 93% specificity in the diagnosis. The HU value and its normalized ratio to hematocrit may be a diagnostic tool for acute cerebral venous thrombosis [18]. In our study, the cut-off value for RMPA HU value to predict PE was found to be 54.8, with a sensitivity of 61.5% and a specificity of 96.4%; the cut-off value for LMPA HU value was 55.9, with a sensitivity of 65.0% and a specificity of 96.4%; the cut-off value for RILA HU value was 62.7, with a sensitivity of 44.4% and a specificity of 96.4%; and the cut-off value for LILA HU value was 56.7, with a sensitivity of 60.0% and a specificity of 92.9%. According to our findings, the HU value value up to the interlobar level may be a diagnostic tool with high specificity for diagnosing PE. Furthermore, the use of the HU value in lower segmental branches for diagnosing PE seems inappropriate, according to our study data.

In our study, between the study and control groups, there were statistically significant differences in the HU value/hematocrit ratio at the RMPA level (1.5-1.1, p=0.006), the LMPA level (1.6-1.2, p=0.007), the RILA level (1.5-1.2, p=0. 047), and the LILA level (1.6-1.2, p=0. 003). Similar hematocrit rates between the two groups may have statistically caused similar differences at the same arterial levels. As a result, we can say that there is a difference between the study and control groups in terms of the HU value/hematocrit ratio up to the level of the interlobar branch.

In our study, the HU value and the HU value/hematocrit ratio were significant up to the interlobar level in both groups. The fact that thrombi in the lower segments did not cause a statistically significant difference may be due to the few segmental emboli present and the shrinking measurement area, making it impossible to make a sufficiently sensitive evaluation.

The study's limitations mention the difficulty of HU value measurements, especially in segmental branches. This limitation concerns that thrombi in segmental branches may not be detected, and thus, a clinical case of PE may be missed. However, it does not change the fact that clinically, non-contrast CT may be helpful as an indirect diagnostic tool in detecting thrombi up to the interlobar level.

Limitations

There are some limitations to this study. In particular, the research was small in scope, single-centered, and retrospective. In addition, and similar to other retrospective studies, there was concern over the possibility of selection bias. However, to eliminate this concern, the study groups were formed by

excluding factors that may cause HU value differences and cases with images that may cause measurement bias. In addition, another limitation was related to HU measurement. HU measurement can vary depending on the measurer and the measurement site, which is a limitation of the study regarding reproducibility. And again, the fact that a single radiologist performs the measurements is a limitation. Finally, we accepted that the measured HU values were normal pulmonary artery HU values because we thought that there was no PTE clot starting from the main pulmonary to distal branches on non-contrast CT. Likewise, we accepted that HU values measured after PTE clot could be either thrombus or normal HU values. Since we could not make this distinction clearly, we wanted to state this as a limitation of the study. Further studies with a significant number of patients and more centers are needed to confirm our findings.

CONCLUSION

In cases of PE, HU values may exhibit high diagnostic specificity on CT, especially for thrombi up to the interlobar level. The HU value of more than 54.8 up to the interlobar level may be alert for the presence of PE.

STATEMENTS

Acknowledgment

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Author contributions

Initials of the contributing authors were listed in brackets after the relevant parts of the research: Literature search (ÖY, MMY), study design (AÇ, MMY), legislative applications (AÇ, MMY, SS), data collection (MMY, SS), supervision and quality control (ÖY, NH), statistical data analysis (MMY), data interpretation (MMY, SS, NH), drafting the manuscript (MMY, AÇ). All authors were involved in the writing and critical revision of the manuscript and approved the final version. AÇ and MMY take the whole responsibility for the paper.

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Availability of data and materials

The authors agree to the conditions of publication including the availability of data and materials in our manuscript.

Conflicts of interest

None declared.

Informed consent

Patients' consents were obtained from the patients before starting the study.

Ethical approval

This study was approved by the institutional review board and ethics committee (Number: E-40465587-050.01.04-657 and ID: 2023/84).

Human rights

The principles outlined in the Declaration of Helsinki have been followed.

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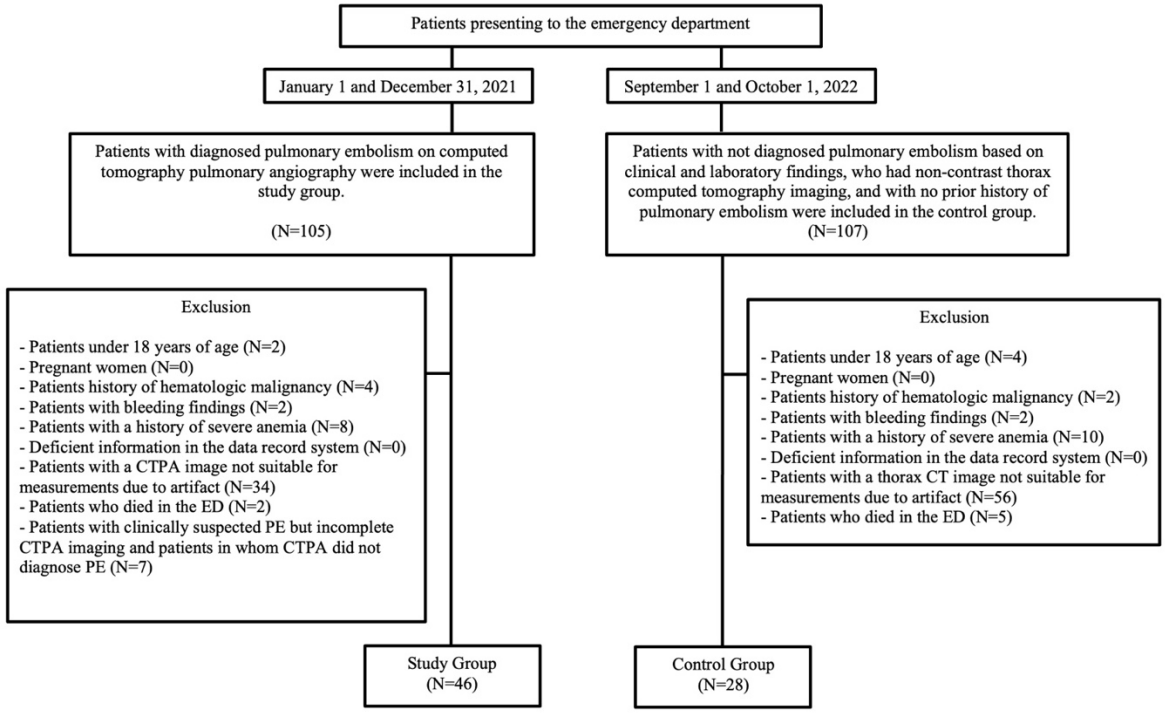
358 **Figure Legends**



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360 **Figure 1: Patient Flow Chart**

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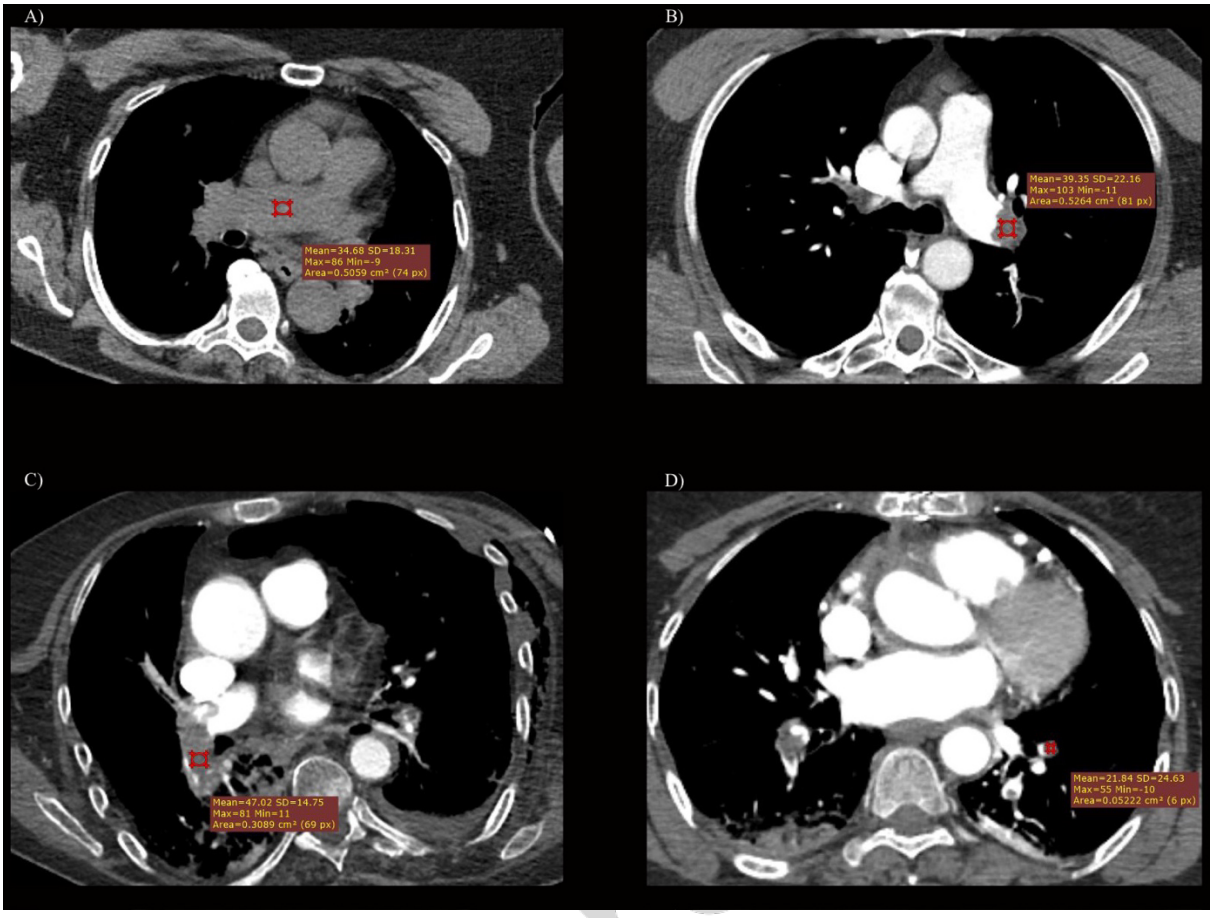
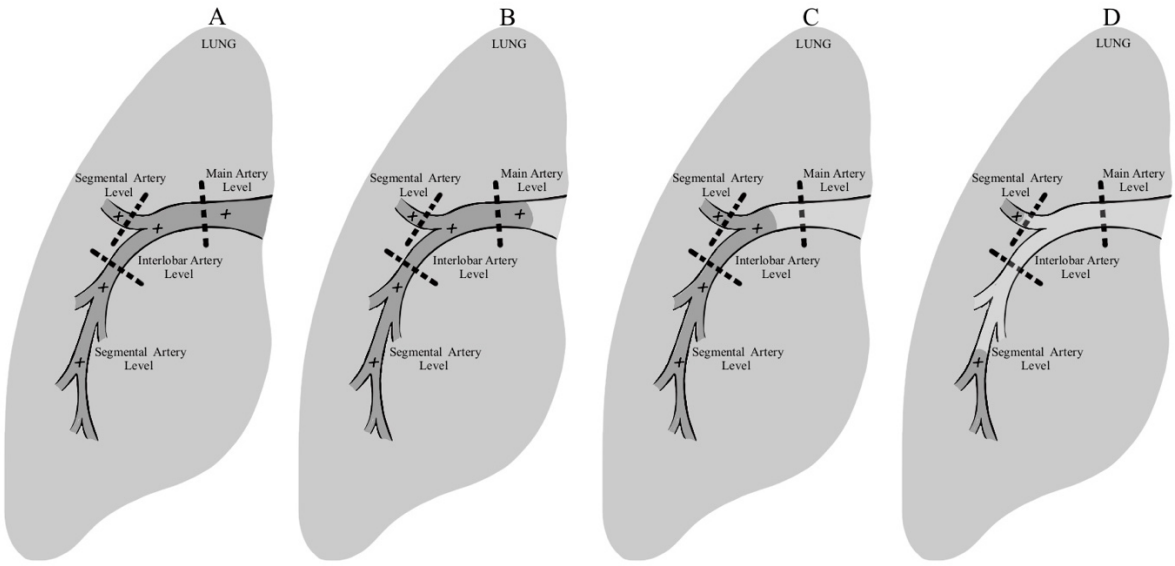


Figure 2: The Measurements of Computed Tomography Scans



A non-contrast thorax CT evaluation was performed, starting from the main pulmonary artery to the distal segmental branches. For standardization of measurements, ROI size of 0.5 cm² was used for the main pulmonary artery (MPA), right main pulmonary artery (RMPA), and left main pulmonary artery (LMPA); ROI size of 0.3 cm² for the right interlobar artery (RILA), and left interlobar artery (LILA); ROI size of 0.05 cm² for the right upper lobe segmentary branch (RULSB), right middle lobe segmentary branch (RMLSB), right lower lobe segmentary branch (RLLSB), left upper lobe segmentary branch (LULSB) and left lower segmentary branch (LLLSB).

In CTPA evaluation, assessment was performed starting from the adjacent part where there was no contrast passage to the distal segmental branches. Similar-sized ROIs were used for the same segments as in non-contrast thorax CT evaluation.ROI size of 0.5 cm² was used for the main pulmonary artery (MPA), right main pulmonary artery (RMPA), and left main pulmonary artery (LMPA); ROI size of 0.3 cm² for the right interlobar artery (RILA), and left interlobar artery (LILA); ROI size of 0.05 cm² for the right upper lobe segmentary branch (RULSB), right middle lobe segmentary branch (RMLSB), right lower lobe segmentary branch (RLLSB), left upper lobe segmentary branch (LULSB) and left lower segmentary branch (LLLSB).

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366 **Figure 3: The Illustrations of Measurements**

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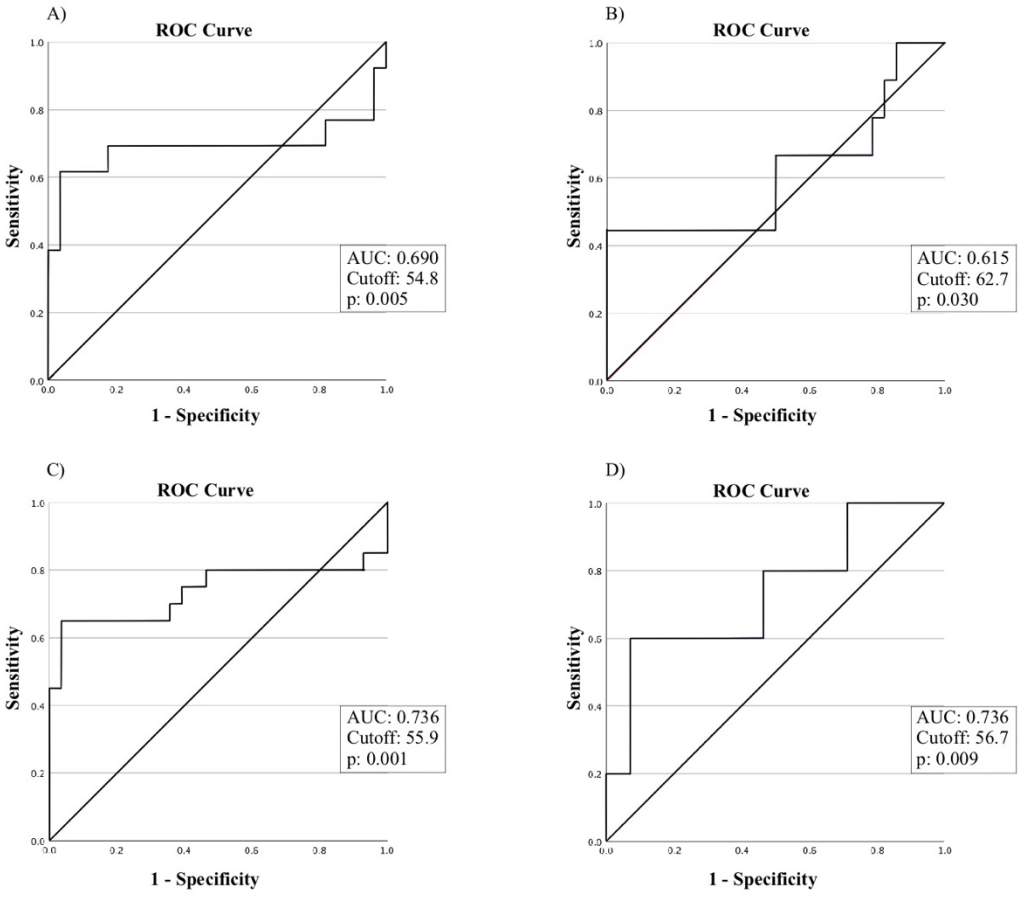

Figure 4: ROC Curve

371 **Table 1- The Patients' Demographic Data and Baseline Characteristics**

	Study Group (n=46)	Control Group (n=28)	All Patients (n=74)	P Value
Gender				
Male	19 (25.7%)	10 (13.5%)	29 (39.2%)	0.633
Female	27 (36.5%)	18 (24.3%)	45 (60.8%)	
Age (Year)	76.5 (IQR 65-85.8)	72 (IQR 67-78.3)	74 (IQR 66-81)	0.475
Comorbidities				
Hypertension	35 (47.3%)	17 (23.0%)	52 (70.3%)	0.161
Diabetes	5 (6.8%)	4 (5.4%)	9 (12.2%)	0.722
CAD	10 (13.5%)	3 (4.1%)	13 (17.6%)	0.347
Atrial Fibrillation	7 (9.4%)	1 (1.4%)	8 (10.8%)	0.245
Stroke	12 (16.2%)	3 (4.1%)	15 (20.3%)	0.111
CHF	3 (4.1%)	2 (2.7%)	5 (6.8%)	1.000
COPD	3 (4.1%)	2 (2.7%)	5 (6.8%)	1.000
Dementia	8 (10.8%)	2 (2.7%)	10 (13.5%)	0.301
Neoplasia	5 (6.8%)	2 (2.7%)	7 (9.5%)	0.703
Admission Symptoms				
Dyspnea	18 (24.3%)	6 (8.1%)	24 (32.4%)	
Chest Pain	10 (13.5%)	6 (8.1%)	16 (21.6%)	
Syncope	5 (6.8%)	4 (5.4%)	9 (12.2%)	0.381
Cough	2 (2.7%)	5 (6.8%)	7 (9.5%)	
Back Pain	7 (9.4%)	4 (5.4%)	11 (14.8%)	
Haemoptysis	4 (5.4%)	3 (4.1%)	7 (9.5%)	
Hematocrit (%)	38.1 ± 6.0	39.1 ± 4.7	38.5 ± 5.6	0.456

IQR: *Interquartile Range****, PE:*** *Pulmonary Embolism,* ***CAD****: Coronary Artery Disease,* ***CHF****: Congestive Heart Failure,* ***COPD****: Chronic Obstructive Pulmonary Disease*

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373 **Table 2- Patients' HU Values and HU/Hematocrit Ratio Statistics**

Study Group		**Control Group**		**All Patients**		**P**
HU Values (n) – mean ± sd (min.-max.)		**HU Values (n) – mean ± sd (min.-max.)**		**HU Values (n) – mean ± sd (min.-max.)**		**Value**
MPA (0)	NaN	MPA (28)	43.5 ± 9.7 (24.9-61.1)	MPA (28)	43.5 ± 9.7 (24.9-61.1)	NaN
RMPA (19)	57.6 ± 27.3 (20.9-122)	RMPA (28)	41.7 ± 7.3 (24.9-64.7)	RMPA (47)	46.7 ± 17.8 (20.9-122)	**0.006**
LMPA (20)	62.0 ± 25.1 (17.5-101)	LMPA (28)	47.2 ± 7.6 (32.6-70.3)	LMPA (48)	53.4 ±18.5 (17.5-101)	**0.005**
RILA (18)	58.2 ± 19.4 (37.5-89.8)	RILA (28)	47.7 ± 9.3 (27.9-62.7)	RILA (46)	50.2 ± 13 (27.9-89.8)	**0.034**
LILA (16)	58.3 ± 19.1 (40.2-89.1)	LILA (28)	44.7 ± 8.9 (27.2-62.1)	LILA (44)	46.8 ± 11.7 (27.2-89.1)	**0.014**
RULSB (5)	34.6 ± 32.5 (11.6-57.6)	RULSB (28)	43.7 ± 12.0 (24.5-75.2)	RULSB (33)	43.1 ± 13.3 (11.6-75.2)	0.359
RMLSB (6)	33.8 ± 2.3 (32.2-35.5)	RMLSB (28)	40.8 ± 13.7 (20.5-67.8)	RMLSB (34)	40.4 ± 13.3 (20.5-67.8)	0.483
RLLSB (4)	37.6 ± 19.1 (12.3-73.0)	RLLSB (28)	43.0 ± 11.3 (25.2-66.1)	RLLSB (32)	41.3 ± 14.2 (12.3-73.0)	0.263
LULSB (5)	40.5 ± 10.5 (40.5-40.5)	LULSB (28)	39.5 ± 10.7 (18.7-66.7)	LULSB (33)	39.5 ± 10.5 (18.7-66.7)	0.932
LLLSB (4)	47.3 ± 24.6 (25.8-85.0)	LLLSB (28)	37.4 ± 10.5 (15.8-54.6)	LLLSB (32)	39.2 ± 14.0 (15.8-85.0)	0.120
Study Group		**Control Group**		**All Patients**		**P**
HU/H Ratio (n) – mean ± sd (min.-max.)		**HU/H Ratio (n) – mean ± sd (min.-max.)**		**HU/H Ratio (n) – mean ± sd (min.-max.)**		**Value**
MPA HU/H (0)	NaN	MPA HU/H (28)	1.1 ± 0.3 (0.7-1.6)	MPA HU/H (28)	1.1 ± 0.3 (0.7-1.6)	NaN
RMPA HU/H (19)	1.5 ± 0.8 (0.5-3.4)	RMPA HU/H (28)	1.1 ± 0.2 (0.5-1.4)	RMPA HU/H (47)	1.2 ± 0.5 (0.5-3.4)	**0.006**
LMPA HU/H (20)	1.6 ± 0.8 (0.5-3.1)	LMPA HU/H (28)	1.2 ± 0.2 (0.7-1.7)	LMPA HU/H (48)	1.4 ± 0.6 (0.5-3.1)	**0.007**
RILA HU/H (18)	1.5 ± 0.6 (0.9-2.6)	RILA HU/H (28)	1.2 ± 0.2 (0.7-1.6)	RILA HU/H (46)	1.3 ± 0.4 (0.7-2.6)	**0.047**
LILA HU/H (16)	1.6 ± 0.5 (1.1-2.4)	LILA HU/H (28)	1.2 ± 0.2 (0.8-1.6)	LILA HU/H (44)	1.2 ± 0.3 (0.8-2.4)	**0.003**
RULSB HU/H (5)	1.0 ± 0.8 (0.4-1.6)	RULSB HU/H (28)	1.1 ± 0.3 (0.7-1.6)	RULSB HU/H (33)	1.1 ± 0.3 (0.4-1.6)	0.567
RMLSB HU/H (6)	0.9 ± 0.2 (0.8-1.1)	RMLSB HU/H (28)	1.1 ± 0.3 (0.5-1.7)	RMLSB HU/H (34)	1.0 ± 0.3 (0.5-1.7)	0.659
RLLSB HU/H (4)	1.0 ± 0.4 (0.4-1.5)	RLLSB HU/H (28)	1.1 ± 0.3 (0.5-1.7)	RLLSB HU/H (32)	1.1 ± 0.3 (0.4-1.7)	0.278
LULSB HU/H (5)	0.9 ± 0.3 (0.9-0.9)	LULSB HU/H (28)	1.0 ± 0.3 (0.4-1.8)	LULSB HU/H (33)	1.0 ± 0.3 (0.4-1.8)	0.620
LLLSB HU/H (4)	1.2 ± 0.6 (0.7-2.1)	LLLSB HU/H (28)	1.0 ± 0.3 (0.4-1.5)	LLLSB HU/H (32)	1.0 ± 0.4 (0.4-2.1)	0.130

__MPA:__ Main Pulmonary Artery, __RMPA:__ Right Main Pulmonary Artery, __LMPA:__ Left Main Pulmonary Artery, __RILA:__ Right Interlobar Artery, __LILA:__ Left İnterlobar Artery, __RULSB:__ Right Upper Lobe Segmental Branches, __RMLSB:__ Right Middle Lobe Segmental Branches, __RLLSB:__ Right Lower Lobe Segmental, Branches, __LULSB:__ Left Upper Lobe Segmental Branches, __LLLSB:__ Left Lower Lobe Segmental Branches, __H:__ Hematocrit, __HU:__ Hounsfield Unit, __HU/H:__ HU Value/ Hematocrit Ratio, __NaN: Not a Number, sd:__ standard deviation, __min.:__ Minimum, __max.:__ Maximum

374 **Table 3- ROC Curve Analysis**

	RMPA for PE	LMPA for PE	RILA for PE	LILA for PE
AUC (95% CI)	0.690 (0.457-0.922)	0.736 (0.563-0.909)	0.615 (0.364-0.866)	0.736 (0.475-0.996)
Cut-off	54.8	55.9	62.7	56.7
Sensitivity, % (95% CI)	61.5 (31.6-86.1)	65.0 (40.8-84.6)	44.4 (13.7-78.8)	60.0 (14.7-94.8)
Specificity, % (95% CI)	96.4 (81.7-99.9)	96.4 (81.7-99.9)	96.4 (81.7-99.9)	92.9 (76.5-99.1)
+ LR (95% CI)	17.3 (2.4-123.8)	18.2 (2.6-128.1)	12.4 (1.6-97.5)	8.4 (1.9-38.2)
- LR (95% CI)	0.4 (0.2-0.8)	0.4 (0.2-0.7)	0.6 (0.3-1.0)	0.4 (0.2-1.3)
PPV, % (95% CI)	88.9 (52.7-98.3)	92.9 (64.9-98.9)	80.0 (33.8-96.9)	60.0 (24.8-87.2)
NPV, % (95% CI)	84.4 (73.1-91.5)	79.4 (67.9-87.6)	84.4 (75.0-90.7)	92.9 (81.6-97.5)
Accuracy, % (95% CI)	85.4 (70.8-94.4)	83.3 (69.8-92.5)	83.8 (68.0-93.8)	87.9 (71.8-96.6)

PE: *Pulmonary Embolism,* ***RMPA:*** *Right Main Pulmonary Artery,* ***LMPA:*** *Left Main Pulmonary Artery,* ***RILA:*** *Right Interlobar Artery,* ***LILA:*** *Left Interlobar Artery,* ***AUC:*** *Area Under the Curve,* ***SD:*** *Standard Deviation,* ***LR:*** *Likelihood Ratio,* ***PPV:*** *Positive Predictive Value,* ***NPV:*** *Negative Predictive Value,* ***CI:*** *Confidence Interval*

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