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Original Research Article

A Prospective Study on the Evaluation of Pulmonary Embolism Using CT Pulmonary Angiography

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Abstract:

Background: Pulmonary embolism (PE) is a dangerous and possibly fatal heart disease that is caused by the blockage of pulmonary arteries, most frequently by thromboemboli, which begin in deep veins. It is linked to high morbidity and mortality and its clinical manifestation is usually unspecified, thus difficult to diagnose. CT Pulmonary Angiography (CTPA) has become the gold standard imaging modality of the accurate and fast diagnosis of PE.

Aim: To assess the diagnostic role of CT Pulmonary Angiography in patients with suspected pulmonary embolism prospectively and to examine the clinical presentations, risk factors, and imaging results.

Methodology: The prospective observational study took place at the Department of Radio-Diagnosis, ICARE Institute of Medical Sciences and Research & Dr. Bidhan Chandra Roy Hospital, Haldia, West Bengal, India, during a one-year period, One hundred and fifty-six patients having clinical suspicion of pulmonary embolism were subjected to CT Pulmonary Angiography. The structured proforma was used to gather data on the demographic characteristics, clinical features, risk factors, and imaging findings, and to analyze the data with descriptive statistics and suitable inferential tests.

Results: Most of the participants were aged 41-60 years (40%), but with a minor male dominance (55%). The most frequent presenting symptom was dyspnea (78%), then came chest pain (55%), and tachycardia (45%). The most prevalent risk factors were immobilization (30%), and deep vein thrombosis (25%). On CTPA, 36% of cases showed pulmonary embolism. Most commonly involved were segmental (25%), and subsegmental (20) arteries but in 10 percent of cases, the main pulmonary artery was involved. Other related discoveries were pulmonary infarction (22%), and effusion of the pleura (18%).

Conclusion: CT Pulmonary Angiography is a sensitive and reliable imaging modality of diagnosing pulmonary embolism. It allows precise disease detection, location and evaluation of the severity of the disease, thus making it easy to manage it clinically in a timely manner. Risk factors and early imaging diagnosis are needed to minimize morbidity and mortality related to pulmonary embolism.

Keywords: Pulmonary embolism, CT Pulmonary Angiography, CTPA, Venous thromboembolism, Risk factors, Imaging findings.

Introduction

Pulmonary embolism (PE) is one of the life-threatening cardiovascular disorders that is associated with the blockage of pulmonary arteries, which is most often caused by thrombi formed in the lower extremity deep veins [1]. It is a significant part of the venous thromboembolism (VTE) and is linked with the high morbidity and mortality rates across the globe. Pulmonary embolism has a wide range of clinical manifestations, including mild symptoms (dyspnea) and severe ones (hemodynamic instability and sudden cardiac death), and in many cases, the identification of the diagnosis can become difficult [2]. In the past, clinical assessment with indirect imaging techniques has been used as the basis of the diagnosis of PE and has resulted in underdiagnosis or misdiagnosis as the symptoms are not specific.

In the last few decades, the development of imaging technology has greatly enhanced the accuracy of diagnosing pulmonary embolism. One of these, CT Pulmonary Angiography (CTPA) has become the imaging modality of choice in the assessment of the suspected PE [3]. CTPA can directly view in-

traluminal fill defects in the pulmonary arterial tree and offers rapid and high-resolution images that can be used to support the diagnosis. Besides emboli detection, CTPA also allows evaluating the size and location of the thrombus, and the other associated results, including pulmonary infarction, pleural effusion, and parenchymal abnormalities, hence making CTPA a complete patient diagnosis [4].

Pulmonary embolism is a worldwide health issue that has an impact on people of all ages and locations [5]. The epidemiological researches claim that PE incidence is estimated to be 60-100 cases/100,000 people/year, and more frequently in hospitalized and elderly patients. It is also on the increase because of better diagnostic abilities and increased clinical awareness [6]. In developing nations, such as India, the incidence of pulmonary embolism might be underreported because of inaccessibility of advanced diagnostic services and awareness of health care professionals. The risk factors that contribute greatly to the development of PE include prolonged immobilization, deep vein thrombosis, recent surgical operation, malignancy and hormonal therapy due to use of hormonal therapy [7].

The pathophysiology of pulmonary embolism includes the development of thrombi which are usually located in the deep veins of the lower limbs and then dislodged and then travel into the pulmonary arteries, resulting in the partial or complete blockage [8]. This results in a lack of gas exchange, pulmonary vascular resistance, and right ventricular load. Unattended PE may lead to some serious complications such as pulmonary infarction, right heart failure and death. Diagnosis and timely treatment are thus important in enhancing patient outcomes [9].

Pulmonary embolism does not just have a great clinical burden, but also has very important economic and social consequences [10]. Patients need to be hospitalized, have advanced imaging, and take long-term anticoagulant therapy, which adds to the expense of healthcare. PE may also cause long-term effects, including chronic thromboembolic pulmonary hypertension (CTEPH), which has an unfavorable impact on the quality of life of people with this condition. The additional burden of the disease is the indirect costs of loss of productivity and extended morbidity [11].

Although there have been improvements in the diagnostic modalities, clinical diagnosis of pulmonary embolism is difficult because of its nonspecific symptoms and similarity with other cardiopulmonary conditions [12]. Thus, there is an increasing demand to have effective, quick, and non-invasive diagnostic methods to accurately identify PE and provide suitable treatment. The CT Pulmonary Angiography has been highly accepted because of its high sensitivity and specificity and thus the technique has become a necessity in the contemporary clinical practice [13].

The current research intends to carry out a future assessment of pulmonary embolism by CT Pulmonary Angiography [14]. The proposed study aims to determine trends and deepen the insights into the diagnostic value of CTPA by examining clinical manifestations, risk factors, and radiographic images of a specific population. The results will be useful in better clinical decision making and management solutions, which will eventually result in improved patient outcomes when suspected pulmonary embolism is involved [15].

Methodology

Study Design: The study was a prospective observational study to determine the role of CT Pulmonary Angiography (CTPA) in the diagnosis of patients suspected of having pulmonary embolism. The research aimed at gathering and analyzing real-time clinical and imaging data in a systematic manner to determine the presence, location, and extent of pulmonary embolism as well as the radiological findings and risk factors. To prevent the need to assess patients only after the study period, and to gain an in-depth picture of the clinical presentation and imaging features of pulmonary embolism, a prospective methodology was chosen.

Study Area: The research was carried out at the Department of Radio-Diagnosis, ICARE Institute of Medical Sciences and Research and Dr. Bidhan Chandra Roy Hospital, Haldia, West Bengal, India.

Study Duration: This was a one-year study, between the 12 months

Study Participants

Inclusion Criteria

- Patients who are clinically suspicious of having pulmonary embolism and are referred to the study center.
- Patients with symptoms of dyspnea, chest pain, hemoptysis, tachycardia or unexplained hypoxia.
- Patients that were referred to CT Pulmonary Angiography within the study period.

Exclusion Criteria

- Contraindicated patients to iodinated contrast media.
- Pregnant women.
- Severely impaired renal patients or patients with known allergy to contrast.
- Patients who do not give informed consent or cannot do so.

Sample Size: The number of patients included in

the study was 200, who met the inclusion criteria. The sample was also chosen so that it could represent the various age groups, clinical presentation and risk profile of pulmonary embolism.

Procedure: Prospective enrolment of patients who met the inclusion criteria was done and CT Pulmonary Angiography was performed on a multidetector CT scanner. Iodinated contrast was given intravenously using a power injector and the image obtainable during the pulmonary arterial phase was taken to achieve maximum visualisation of the pulmonary vasculature. The CT images were reviewed systematically if they contained intraluminal filling defects which are characteristic of pulmonary embolism as well as the location (main, lobar, segmental, or subsegmental arteries) and extent of emboli. Pulmonary infarction, pleural effusion, atelectasis and parenchymal abnormalities were also reported. Data such as clinical data, such as demographic, presenting symptoms, and predisposing risk factors, were noted with a structured proforma in order to ensure consistency in data gathering. Strict patient confidentiality was upheld and the Institutional Ethics Committee of the hospital gave ethical clearance before the study started.

Statistical Analysis: Data obtained were inputted into SPSS version 27.0 (IBM, USA) to be statistically analyzed. Continuous and categorical variables were analyzed using descriptive statistics that included: mean, standard deviation, frequency, and percentage. Chi-square tests of the categorical variables and independent t-tests of the continuous variables were used to evaluate associations between clinical variables, risk factors, and imaging results. Multivariate logistic regression was done to find out important predictors of pulmonary embolism and adjusting possible confounding factors. The p-value of less than 0.05 was taken as statistically significant.

Result

Table 1 shows the demographic features of the 200 participants of the study that were used in the analysis. The age distribution shows that the highest percentage of participants were aged 4160 years (80, 40%), then were aged 1860 years (60, 30%), and lastly aged over 60 years (60, 30%). In reference to gender, males represented a bit more population in the study (110, 55%), with females totaling 90 (45%). These demographic features can be visually described in Figure 1, as they are the representation of a small majority of middle-aged individuals and a fringe marginal male dominance in the study group.

Table 1: Demographic Characteristics of Study Participants

Parameter	Category	Frequency (n)	Percentage (%)
Age (years)	18–40	60	30
	41–60	80	40
	>60	60	30
Gender	Male	110	55
	Female	90	45

Figure 1: Visual Representation of Demographic Characteristics of Study Participants

The findings indicate that middle-aged persons (41-60 years) are more likely to be suspected of pulmonary embolism and this may be explained by the fact that in this age group there is a higher exposure to risk factors like sedentary lifestyle, comorbidities and postoperative conditions. The almost equal

representation of younger adults and older patients in the sample of patients with pulmonary embolism shows that the problem of pulmonary embolism is still a clinically significant issue of the broad age range. The marginally high male dominant in this study could be due to the gender differences in risk factor exposure, including increased smoking, occupational immobility, or cardiovascular risk factors in males. Nonetheless, the gender balance, which is quite close, also indicates that both genders equally suffer the impact of pulmonary embolism and must be equally addressed in a clinical assessment irrespective of the gender.

Table 2 presents the clinical manifestation of the 200 participants in the study that were suspected to have pulmonary embolism. The most common reported symptom was dyspnea, which was reported in 156 patients (78%), and then there were 110 patients with chest pain (55%). Tachycardia was observed in 90 participants (45%), and cough in 70 patients (35%). The least frequent symptom was hemoptysis, which was seen in 40 patients (20%). Figure 2 visually represents these clinical features, with dyspnea being the most common presenting complaint, then chest pain, tachycardia, and somewhat less common are cough and hemoptysis.

Table 2: Clinical Presentation in Study Participants

Clinical Feature	Frequency (n)	Percentage (%)
Dyspnea	156	78
Chest pain	110	55
Cough	70	35
Tachycardia	90	45
Hemoptysis	40	20

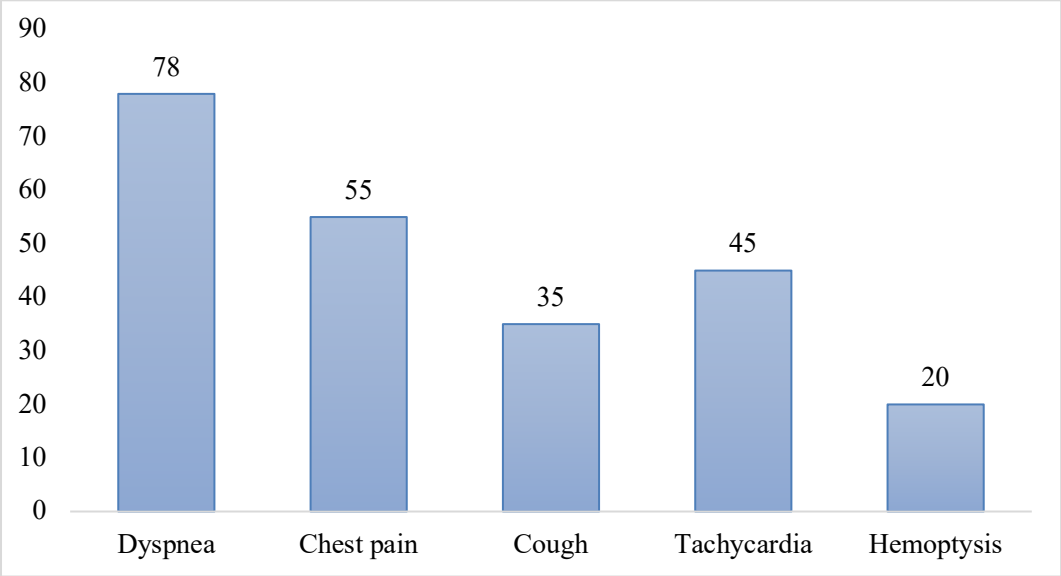

Figure 2: Visual Representation of Clinical Presentation in Study Participants

The fact that dyspnea is predominant shows that the most important and most common clinical expression of suspected pulmonary embolism is respiratory distress. The high prevalence of chest pain also indicates the classic manifestation of PE which is usually related to pleuritic involvement. Tachycardia is present in almost half of the patients, is a sign of physiological reaction to hypoxia and hemodynamic stress of pulmonary arterial obstruction. The presence of cough and hemoptysis was not so common, but their presence is clinically significant, especially hemoptysis, which can suggest pulmonary infarction. In general, the results highlight that although some of the symptoms are very suggestive of pulmonary embolism such as dyspnea and chest pain, the clinical presentation is heterogeneous, therefore, a high index of suspicion is warranted and imaging techniques such as CT Pulmonary Angiography can be considered crucial in making a diagnosis.

Table 3 shows the risk factor distribution of pulmonary embolism in the 200 participants of the study. The most frequent risk factor was immobilization which was found in 60 patients (30%), then deep vein thrombosis was found in 50 patients (25%). In 40 participants (20%), recent surgery was detected and in 30 patients (15%), malignancy was detected. The use of oral contraceptives was the least used risk factor with 20 patients (10%). These risk factors have been represented graphically in figure 3 and it is clear that the greatest contributors to pulmonary embolism in the study population are immobilization and thromboembolism conditions such as deep vein thrombosis.

Table 3: Risk Factors for Pulmonary Embolism

Risk Factor	Frequency (n)	Percentage (%)
Immobilization	60	30
Deep vein thrombosis	50	25
Recent surgery	40	20
Malignancy	30	15
Oral contraceptive use	20	10

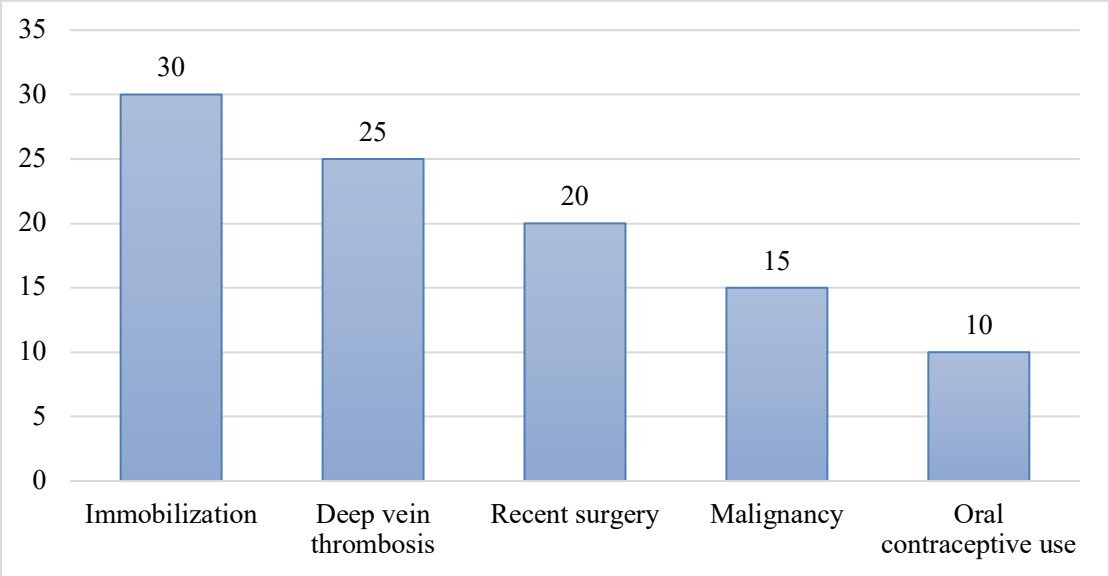

Figure 3: Visual Representation of Risk Factors for Pulmonary Embolism

The overwhelming presence of immobilization as a risk factor underscores its severity in the onset of venous thromboembolism, probably because of the stasis of venous blood and decreased blood circulation in the immobilized patients. The fact that deep vein thrombosis is also common further supports the fact that it is closely related to pulmonary embolism since the thrombi that start in the lower extremities usually travel to the pulmonary circulation. Postoperative hypercoagulability and protracted immobilization also became apparent in recent surgery which was the major contributor. The fact that malignancy is present in a significant percentage of the patients shows the contribution of the cancer-associated thrombosis to the risk of pulmonary embolism. Even though the use of oral contraceptives was not very common, they still play a clinically significant role especially in younger female patients because they are prothrombotic. In general, the results highlight the fact that pulmonary embolism is closely linked with the presence of recognizable and frequently avoidable risk factors that may necessitate both the timely risk evaluation and prophylaxes in individuals at high risk.

Table 4 shows the CT Pulmonary Angiography (CTPA) results of 200 participants of the study. The presence of intraluminal filling defects was found in 72 patients (36%) who were diagnosed with pulmonary embolism. The most common level of arterial involvement was segmental arteries (50, 25%), then subsegmental arteries (40, 20%). The 30 patients (15%), and 20 patients (10%) had lobar artery and main pulmonary artery involvement respectively. These findings are visually represented in Figure 4 showing that the emboli were more likely to be found in the peripheral branches of pulmonary arterial tree especially at the segmental and sub-segmental levels.

Table 4: CT Pulmonary Angiography Findings

Finding	Frequency (n)	Percentage (%)
Pulmonary embolism detected	72	36
Main pulmonary artery	20	10
Lobar arteries	30	15
Segmental arteries	50	25
Subsegmental arteries	40	20

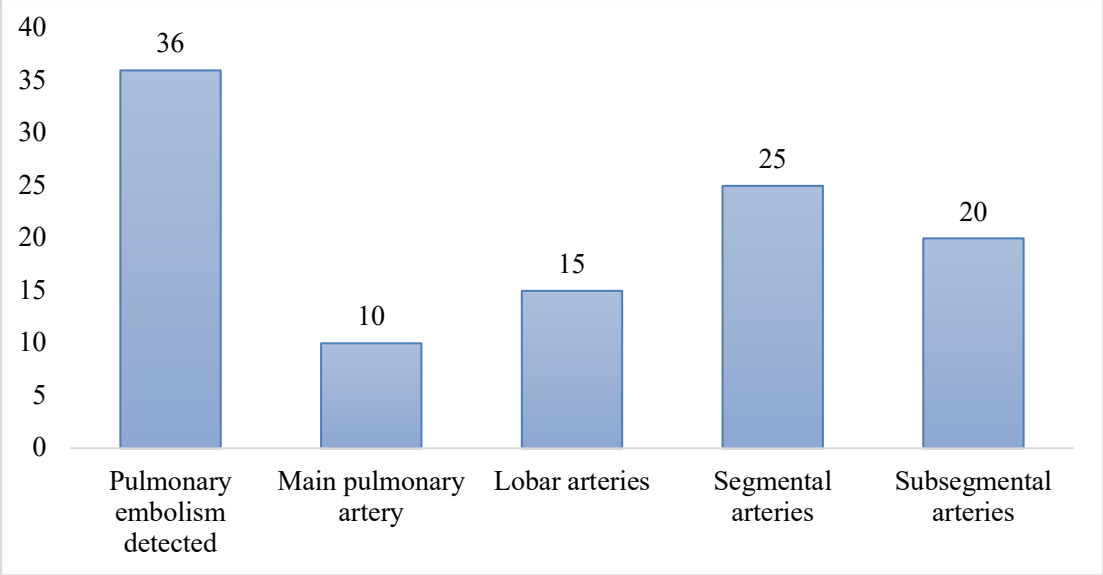

Figure 4: Visual Representation of CT Pulmonary Angiography Findings

The results of the CT Pulmonary Angiography diagnostic yield in clinically suspected cases are clearly indicated by the detection of pulmonary embolism in 36% of the study population. The increased prevalence of emboli in segmental and subsegmental vessels implies that smaller, more peripheral vessels are more frequently involved, which could be indicative of a more early-progression disease or better detection sensitivity of contemporary multidetector CT scanners. Less common, but clinically significant, the lobar and main pulmonary arteries are involved, which is usually accompanied by a greater hemodynamic deficit and an increased risk of morbidity and mortality. These results show that CTPA is a sensitive test to detect emboli at various levels of the pulmonary arterial tree, and is critical to not only confirm the diagnosis, but also determine the severity and extent of pulmonary embolism, which is vital to inform the appropriate clinical treatment.

Discussion

The current prospective study examined the role of CT Pulmonary Angiography (CTPA) in the diagnosis of pulmonary embolism and the demographic trend, clinical presentation, risk factors, and imaging in pulmonary embolism (Doğan et al., 2015) [16]. The research showed that the pulmonary embolism was most likely to be suspected in the middle-aged population (4160 years), which is in line with the prevalence of comorbid conditions, decreased mobility, and increased exposure to the risk factors contributing to thromboembolism among middle-aged people (Van der Hulle et al., 2017) [17]. The small male bias observed in this study can be linked to prior reports that indicate that risk factors like smoking, occupational immobility, and cardiovascular diseases are more prevalent in males, but pulmonary embolism continues to be a major clinical issue in both sexes.

Clinically, dyspnea was the most common symptom, then chest pain and tachycardia as per the classical symptomatology of pulmonary embolism (Hoey et al., 2011) [18]. These results are consistent with the existing literature, in which respiratory distress and pleuritic chest pain are regarded as typical symptoms of PE. Nevertheless, the inconsistency of the symptoms, especially the less common ones like hemoptysis and cough, reflects the non-specificity of the disease and stresses the significance of a high index of clinical suspicion. The well-established pathophysiological nature of venous thromboembolism is further promoted by the identification of key risk factors like immobilization, deep vein thrombosis, recent operation, and malignancy. The results underscore the importance of early risk evaluation and preventive measures, particularly among high-risk patients in the hospital and post-surgery (Mamlouk et al., 2010) [19].

CTPA imaging results of the present study highlight the diagnostic capability of CTPA where pulmonary embolism was identified in 36 percent suspected cases. The preponderance of emboli in segmental and subsegmental vessels is a pointer that peripheral pulmonary vasculature is involved, which can be explained by the enhanced sensitivity of the current multidetector CT technique. Main and lobar pulmonary artery involvement is not very common, but is also clinically important because of its correlation with severe hemodynamic outcomes (Vedovati et al., 2013) [20]. Also, related results like pulmonary infarction and pleural effusion are detected, which also emphasize the overall diagnostic power of CTPA. All in all, the analysis confirms that CT Pulmonary Angiography is a stable, fast, and high sensitivity imaging system that not only confirms the diagnosis of pulmonary embo-

lism but also provides important data as to the severity of the disease and the way to approach it clinically.

Conclusion

The current prospective study emphasizes the importance of CT Pulmonary Angiography (CTPA) in accurate diagnosis and assessment of the pulmonary embolism in clinically suspected patients. The results indicate that pulmonary embolism is usually seen in middle-aged patients with a slight male bias and is often linked with any of the identifiable risk factors that include immobilization, deep vein thrombosis, and recent surgery. The clinical manifestations most common were dyspnea and chest pain, but there was variability in the presentation and this highlights the importance of having a high index of clinical suspicion. CTPA was shown to be a very sensitive and dependable imaging modality, capable of identifying emboli at various levels of the pulmonary arterial tree, especially in segmental and subsegmental arteries, and complications related to emboli such as pulmonary infarction and pleural effusion. In general, risk factors should be identified early and CTPA used promptly to aid in timely diagnosis, treatment, and, eventually, lower the morbidity and mortality of pulmonary embolism.

References

1. Stein, P. D., Chenevert, T. L., Fowler, S. E., Goodman, L. R., Gottschalk, A., Hales, C. A., ... & PIOPED III (Prospective Investigation of Pulmonary Embolism Diagnosis III) Investigators*. (2010). Gadolinium-enhanced magnetic resonance angiography for pulmonary embolism: a multicenter prospective study (PIOPED III). Annals of internal medicine, 152(7), 434-443.
2. El-Menyar, A., Nabir, S., Ahmed, N., Asim, M., Jabbour, G., & Al-Thani, H. (2016). Diagnostic implications of computed tomography pulmonary angiography in patients with pulmonary embolism. Annals of thoracic medicine, 11(4), 269-276.
3. den Exter, P. L., van Es, J., Kroft, L. J., Erkens, P. M., Douma, R. A., Mos, I. C., ... & Prometheus Follow-Up Investigators. (2015). Thromboembolic resolution assessed by CT pulmonary angiography after treatment for acute pulmonary embolism. Thrombosis and haemostasis, 114(07), 26-34.
4. Bach, A. G., Nansalmaa, B., Kranz, J., Taute, B. M., Wienke, A., Schramm, D., & Surov, A. (2015). CT pulmonary angiography findings that predict 30-day mortality in patients with acute pulmonary embolism. European journal of radiology, 84(2), 332-337.
5. Crichlow, A., Cuker, A., & Mills, A. M. (2012). Overuse of computed tomography pulmonary angiography in the evaluation of patients with suspected pulmonary embolism in the emergency department. Academic Emergency Medicine, 19(11), 1219-1226.
6. Kumamaru, K. K., Saboo, S. S., Aghayev, A., Cai, P., Quesada, C. G., George, E., ... & Rybicki, F. J. (2016). CT pulmonary angiography-based scoring system to predict the prognosis of acute pulmonary embolism. Journal of cardiovascular computed tomography, 10(6), 473-479.
7. Atasoy, M. M., Sariman, N., Levent, E., Çubuk, R., Çelik, Ö., Saygi, A., ... & Sahin, S. (2015). Nonsevere acute pulmonary embolism: prognostic CT pulmonary angiography findings. Journal of computer assisted tomography, 39(2), 166-170.
8. Shahir, K., Goodman, L. R., Tali, A., Thorsen, K. M., & Hellman, R. S. (2010). Pulmonary embolism in pregnancy: CT pulmonary angiography versus perfusion scanning. American journal of roentgenology, 195(3), W214-W220.
9. Donato, A. A., Khoche, S., Santora, J., & Wagner, B. (2010). Clinical outcomes in patients with isolated subsegmental pulmonary emboli diagnosed by multidetector CT pulmonary angiography. Thrombosis research, 126(4), e266-e270.
10. Ceylan, N., Tasbakan, S., Bayraktaroglu, S., Cok, G., Simsek, T., Duman, S., & Savaş, R. (2011). Predictors of clinical outcome in acute pulmonary embolism: Correlation of CT pulmonary angiography with clinical, echocardiography and laboratory findings. Academic radiology, 18(1), 47-53.
11. Stein, P. D., Yaekoub, A. Y., Matta, F., Janjua, M., Patel, R. M., Goodman, L. R., ... & Denier, J. E. (2010). Resolution of pulmonary embolism on CT pulmonary angiography. American Journal of Roentgenology, 194(5), 1263-1268.
12. Wiener, R. S., Schwartz, L. M., & Woloshin, S. (2013). When a test is too good: how CT pulmonary angiograms find pulmonary emboli that do not need to be found. Bmj, 347.
13. Kligerman, S. J., Lahiji, K., Galvin, J. R., Stokum, C., & White, C. S. (2014). Missed pulmonary emboli on CT angiography: assessment with pulmonary embolism–computer-aided detection. American Journal of Roentgenology, 202(1), 65-73.
14. Albrecht, M. H., Bickford, M. W., Nance Jr, J. W., Zhang, L., De Cecco, C. N., Wichmann, J. L., ... & Schoepf, U. J. (2017). State-of-the-art pulmonary CT angiography for acute pulmonary embolism. American Journal of Roentgenology, 208(3), 495-504.
15. Duru, S., Ergun, R., Dilli, A., Kaplan, T., Kaplan, B., & Ardic, S. (2012). Clinical, laboratory and computed tomography pulmonary angi-

ography results in pulmonary embolism: retrospective evaluation of 205 patients/Pulmoner embolide klinik, laboratuvar ve bilgisayarli tomografi pulmoner anjiyografi sonuclari: 205 hastanin retrospektif degerlendirmesi. The Anatolian Journal of Cardiology (Anadolu Kardiyoloji Dergisi), 12(2), 142-150.

16. Doğan, H., de Roos, A., Geleijins, J., Huisman, M. V., & Kroft, L. J. (2015). The role of computed tomography in the diagnosis of acute and chronic pulmonary embolism. Diagnostic and Interventional Radiology, 21(4), 307.
17. Van der Hulle, T., Cheung, W. Y., Kooij, S., Beenen, L. F., van Bemmel, T., van Es, J., ... & del Sol, A. I. (2017). Simplified diagnostic management of suspected pulmonary embolism (the YEARS study): a prospective, multicentre, cohort study. The Lancet, 390(10091), 289-297.
18. Hoey, E. T., Mirsadraee, S., Pepke-Zaba, J., Jenkins, D. P., Gopalan, D., & Screaton, N. J. (2011). Dual-energy CT angiography for assessment of regional pulmonary perfusion in patients with chronic thromboembolic pulmonary hypertension: initial experience. American Journal of Roentgenology, 196(3), 524-532.
19. Mamlouk, M. D., vanSonnenberg, E., Gosalia, R., Drachman, D., Gridley, D., Zamora, J. G., ... & Ornstein, S. (2010). Pulmonary embolism at CT angiography: implications for appropriateness, cost, and radiation exposure in 2003 patients. Radiology, 256(2), 625-632.
20. Vedovati, M. C., Germini, F., Agnelli, G., & Becattini, C. (2013). Prognostic role of embolic burden assessed at computed tomography angiography in patients with acute pulmonary embolism: systematic review and meta-analysis. Journal of Thrombosis and Haemostasis, 11(12), 2092-2102.