Journal of
Cardio - Thoracic Medicine

http://jctm.mums.ac.ir

Incidental Findings in Patients Evaluated for Pulmonary Embolism Using Computed Tomography Angiography

Masoud Pezeshki Rad[1]*, Donya Farrokh Tehrani[2], Hamidreza Reihani[3], Seyed Hosein Faghih Sabzevari[2], Mehrdad Rajabi[4]

[1] *Radiologist, Vascular and Endovascular Surgery Research Center, Imam Reza Hospital, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran*
[2] *Radiologist, Radiology Department, Imam Reza Hospital, Mashhad University of Medical Sciences, Mashhad, Iran*
[3] *Emergency Medicine Specialist, Emergency Medicine Department, Imam Reza Hospital, Mashhad University of Medical Sciences, Mashhad, Iran*
[4] *Resident of Radiology, Radiology Department, Imam Reza Hospital, Mashhad University of Medical Sciences, Mashhad, Iran*

ARTICLE INFO

Article type:
Original article

Article history:
Received: 22 Feb 2014
Revised: 17 Mar 2014
Accepted: 10 Apr 2014

Keywords:
CT Scan
Pulmonary CT Angiography
Pulmonary Embolism

ABSTRACT

Introduction: Pulmonary embolism (PE) is a common lethal disease that its clinical symptoms may be seen in many other diseases. Computed tomography pulmonary angiography (CTPA) is a valuable diagnostic modality for detection of PE. In addition, it can accurately detect the other diseases with clinical symptoms similar to PE. The aim of this study is to evaluate the frequency of PE and non-embolic disease with similar clinical symptoms including pulmonary, pleural, mediastinal, and cardiovascular diseases that have been detected by CTPA and to describe the importance of reporting these CT findings.

Materials and Methods: In this cross-sectional study, we evaluated the medical records of CTPA in 300 patients of suspected PE between March 2012 and February 2013 in Imam Reza Hospital and Ghaem Hospital in Mashhad University of Medical Sciences, Mashhad, Iran. Demographic information and the results of CTPA of these patients were re-evaluated. One radiologist reviewed all of the CTPA and the results have been analyzed by SPSS-16 software.

Results: In this study, PE was detected in 18.7% of patients. Multiple incidental imaging findings were diagnosed as follow: pulmonary consolidation (33.2%), pleural effusion (48.7%), pulmonary nodules (10%), pulmonary masses (1.3%), pneumothorax (4.7%), mediastinal mass and lymphadenopathy (9.3%), aortic calcification (42%), coronary arteries calcification (27.3%), mitral valve calcification (2 %), cardiomegaly (30.7%), and the evidences of right ventricular dysfunction (6.7%).

Conclusion: A group of disease can cause the clinical symptoms similar to that of PE. Among them, pulmonary consolidation and pleural effusion have much higher frequency than PE. In addition, CTPA can show pathologic findings in the patients that need follow-up. It is important to detect and report these imaging findings because some of them may change the treatment and prognosis of patient who are suspected to have PE.

►*Please cite this paper as:*
Pezeshki Rad M, Farrokh Tehrani D, Reihani H, Faghih Sabzevari SH, Rajabi M. Incidental Findings in Patients Evaluated for Pulmonary Embolism Using Computed Tomography Angiography. J Cardiothorac Med. 2014; 2(2): 162-166.

Introduction

Pulmonary embolism (PE) is a common challenging problem and one of the most common causes of preventable death in the emergency departments. PE is caused by thrombosis in venous system. In many parts of the world, it is the third cause of death in

**Corresponding author:* Masoud Pezeshki Rad, Vascular and Endovascular Surgery Research Center, Imam Reza Hospital, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran. Tel: 09151131491; Fax: 05118525004; Email: pezeshkiradm@mums.ac.ir

humans. PE can be symptomatic and it may be life threatening too, therefore, it requires accurate and relatively fast diagnosis. Computed tomography pulmonary angiography (CTPA) is one of the best imaging methods for diagnosis the presence of PE in the main pulmonary artery and its branches. The multi detector computed tomography (MDCT) scan has provided a powerful tool for imaging the pulmonary arteries (1). This modality is the imaging technique of choice for identifying the direct sign of PE. It enables direct visualization of thrombus as an intra-arterial filling defect in the main pulmonary artery and its branches. The sensitivity and specificity of this method for detection of PE in the main pulmonary artery, lobar and segmental branches have been reported more than 90 % (2).

Symptoms of PE are varied, including dyspnea (84%), pleuretic chest pain (74%), anxiety (59%), and cough (53%) (3). The clinical symptoms of PE are non-specific and symptoms such as dyspnea, cough, hypotension, and hemoptysis can be observed in many other diseases including pulmonary and cardiovascular diseases. CTPA in addition to identifying vascular lesions and PE can clearly detect different lesions in the lung parenchyma, mediastinum, and cardiovascular system. In many patients, early clinical symptoms are related to these lesions and not to the PE. In patients with suspected PE, radiologists and clinicians usually do not pay much attention to the imaging findings other than the presence of PE in the main pulmonary artery and its branches (4).

In several studies, infection and pleural effusion were the two main differential diagnosis of PE, which may simultaneously be present in a significant number of patients with PE (5, 6).

Rashid *et al* reported that in their study with 64 multi-detector pulmonary CT angiography, PE was observed in 25 cases (38%) and it was negative in 40 cases (61%), In patients without PE, 12 cases did not have any other signs in the CT scan, and in the remaining cases pleural effusion, infection and tumor were three common findings (7).

In another study, which was published in 2009 by William BH, among 589 CT angiographies, 9% detected PE, 81% revealed other findings except PE, and 33% had other diagnosis that justified their symptoms (8).

The aim of this study is to evaluate the frequency of PE and non-embolic findings with similar clinical symptoms including pulmonary, pleural, mediastinal, and cardiovascular that have been detected by CTPA and to describe the importance of reporting these CT findings.

Materials and Methods

This cross sectional study was performed between March 2012 and February 2013, at two educational and research hospitals including Imam Reza and Ghaem Hospitals of Mashhad university of Medical Sciences in Iran. In this study, 300 consecutive CTPA examinations that were performed by one of the NeuViz 16 -16 - Slice Scanner Systems (Neosoft® Medical) in patients with suspected acute PE were retrospectively reviewed.

One radiologist observed the CTPA images with specialty in report of them. A questionnaire was filled for each patient as to whether or not a PE was demonstrated and if any additional imaging findings was observed. Additional findings demonstrated were also recorded, with particular interest given to incidental findings or pathology that was completely unsuspected. The re-evaluation of the CTPA images was done regardless of the reported findings in the medical records of the subjects.

The mentioned incidental findings included pulmonary consolidation, pleural effusion, pulmonary nodules, pulmonary masses, lung collapse, pneumothorax, mediastinal mass or lymphadenopathy, the presence of calcification in aortic wall, mitral valve and coronary arteries, aortic dilatation, cardiomegaly, and the signs of right ventricular dysfunction.

The patients were classified to three groups: The first category with mimic clinical symptoms of PE was as following: consolidation (equivalent infiltration or infection), pleural effusion, lung collapse (equivalent atelectasis) ,aortic dilatation or aneurism, and pneumothorax . The second category was CT findings that require more clinical or radiological investigations including pulmonary nodules, pulmonary mass, mediastinal mass and lymphadenopathy. And the third category of imaging findings that do not require follow up and emergency care including: aortic and coronary artery calcification, mitral valve calcifications and cardiomegaly. The signs of right ventricular dysfunction (reflux of contrast material into inferior vena cava and ventricular septum deviation was also noted.

Statistical Analysis

The collected data of the patients were entered to SPSS version 16, for statistical analysis. The mean and standard deviation of the quantitative variables were calculated and presented in table and bar-chart. For inferential statistics, Chi-Square test was used. In all measurements P-value less than 0.05 was considered statistically significant.

Table1. The frequency of incidental findings, which can mimic clinical symptoms of acute PE (First category)

	PE patients	Non-PE patients	The Chi square result
Consolidation	32.1%	32.7%	0.932
Pleural effusion	53.6%	51.6%	0.764
Collapse	17.9%	11.5%	0.202
Aortic dilatation	3.6%	4.4%	0.777
Pneumothorax	3.6%	4.4%	0.777
Existence of at least one of the above	64.3%	61.1%	0.657

Table2. The frequency of CT findings that require more clinical or radiological investigations (second category)

Findings	Patients (%)
Pulmonary nodules	30 (10%)
Pulmonary mass	14 (4.9%)
Mediastinal mass	4 (1.3%)
Lymphadenopathy	28 (9.3%)

Table3. The frequency of CT findings that do not require follow up or emergency care (third category)

Findings	Patients (%)
Aortic calcification	126 (42%)
Coronary artery calcification	82 (27.3%)
Mitral valve calcifications	6 (2.1%)
Cardiomegaly	92 (30.7%)

Results

In this study CTPA of 300 patients suspected of acute PE were evaluated, 202 patients (67.3%) were from Imam Reza hospital and 98 cases (32.7%) were from Ghaem hospital. In the terms of quality, 18 (6%) CTPA examination were unacceptable and 282 (94%) had acceptable quality for evaluation. The youngest patient was six years old, the oldest was 87 years old, and the mean age of patients was 54.6 years. In this study, 126 patients (58%) were male and 174 cases (42%) were female.

Among the 282 patients who had acceptable CTPA, there were evidences of PE in the main pulmonary artery, segmental, or sub segmental arteries in 56 patients (18.7%). In 226 patients, (81.3%) there was no evidence of PE in any of the main pulmonary arteries, segmental or sub-segmental branches. The youngest patient with PE was 19 years old and the oldest was 86 years old.

Among the CTPA that were positive for the presence of PE, the embolism was located in the left main pulmonary artery in 30 patients (10%), left segmental arteries in 34 patients (11.3%), left sub -segmental arteries in 26 patients (8.7%), right main pulmonary artery in 36 patients (12%), right segmental arteries in 48 cases (16%) and right sub-segmental arteries in 34 cases (11.3%).

The frequency of important incidental findings (first category) is shown in Table 1. There was no significant difference between PE patients and non-PE patients according to these findings.

Consolidation was seen in 100 patients (33.3%) and the locations of the consolidation were as follow; left upper lobe (30 patients, 10%), lingula lobe (26 patients, 8.7%), left lower lobe (44 patients, 14.7%), right upper lobe (22 patients, 7.3%), right middle lobe (22 patients, 7.3%), and right lower lobe (62 patients, 20.7%). Forty patients (13.3%) had evidences of lung collapse. Among these patients, there was no evidence of collapse in the left or right upper lobe. Lung collapse was detected in lingula lobe in 6 patients (2%), in left lower lobe in 14 patients (4.7%), in right lower lobe in 28 patients (9.3%), and in right middle lobe in 2 patients (0.7%). The pattern of collapse among our patients was as follow: 22 cases (7.3 %) lobar, 14 cases (4.7 %) lobar and segmental, and 8 cases (2.7 %t) sub-segmented.

Table 2 shows the frequency of CT findings that require more clinical or radiological investigations (2nd category) in all CTPAs. Table 3 shows the frequency of CT findings that do not require follow up or emergency care (3rd category).

Discussion

PE is a major cause of morbidity and mortality and, despite much research, remains a diagnostic challenge due to its non-specific presentation. PE often arises from the pelvic veins, or venous system of the lower limbs. When acute deep venous thrombosis above the knee left untreated, in half of the patients, clinical PE will occur. A significant number of asymptomatic patients are suffering from subclinical PE. The mortality rate of untreated PE is approximately 30%, thus rapid and accurate diagnosis is imperative to reduce mortality. PE can be a symptomatic and life threatening disease and it requires early and accurate diagnosis. Today pulmonary angiography with MDCT has become the imaging method of choice for detection of PE because of its accuracy, lower observer variability, speed, and also ability to provide alternative diagnosis with similar clinical symptoms as PE (14).

CTPA enables direct visualization of thrombus as an intra-arterial filling defect and it can also detect both parenchyma and mediastinal structures.

Anderson and colleagues performed a study in 2007 and they evaluated 1417 patients by CTPA and perfusion scan for detection of small

PE and it was determined that PCTA has a greater ability to detect small embolisms (10).

It is important to know that when the CT slices are thinner, the reconstructed images quality and enhanced diagnostic power of this technique will be increased in diagnosis of PE. Nishino *et al*, reported that the best quality of thoracic imaging for detection of PE can be achieved with 64 multi-detector computed tomography (MDCT) (11). The rate of PE diagnosis was reported from 15% to 66% in different studies using 16-slice MDCT pulmonary angiography. With increasing the quality of CTPA images there is also an increase in detecting incidental findings (12, 13).

The frequency of PE in our study was lower than that of Rashid´s study (7). In a study that has been conducted by William Hall and colleagues, the CTPA of 589 patients of suspected acute PE were evaluated (8). In this study, PE was detected in 55 patients (9%) which is less frequent than our study. As can be observed, the frequency of embolism in our study is between the two studies that were performed by Rashid and William Hall (7, 8). The reason for this dissimilarities can be related to the difference in sample size, difference in quality of devices (Rashid used 64 multi detector CT scan and we used 16 multi detector CT scan), and also due to the difference in radiologist ´s opinion.

Non-PE findings were classified in three categories in our study. The first category, which can mimic clinical symptoms of acute PE, includes consolidation (equivalent infiltration or infection), pleural effusion, lung collapse (equivalent atelectasis), aortic dilatation or aneurysm and pneumothorax .The frequency of consolidation and pleural effusion were more common in our study comparing with William Halls' study (8). The frequency of consolidation in Rashid ´ study was also lower than our study (7).

The frequency of aortic aneurysm in William Hall's study has been less than 1%, which is much lower than our study (8). One reason for this difference could be that in William Hall ´study, the aortic aneurysm was investigated instead of aortic dilatation, which we have evaluated separately in this study.

The frequency of atelectasis (collapse) in our study was higher than William Hall ´s study which was reported 3% (8). One reason for this difference is that in William Hall´s study the diagnosis of atelectasis was limited to remarkable cases. It is interesting that although pneumothorax can mimic the clinical symptoms of PE, it was not investigated in other similar studies. We found 14 patient with pneumothorax in all 300 reviewed CTPAs in our study.

The second category is CT findings that require more clinical or radiological investigations, including pulmonary nodules, pulmonary mass, mediastinal mass and lymphadenopathy. The frequency of pulmonary nodules in William Hall's study was much higher than our study. The frequency of lung masses in our study was approximately the same as that reported by William Hall and colleagues. However, pulmonary masses were more common in Rashid ´s study than our study. One of the reasons for this difference can be the difference between two sample sizes (7).

The frequency of mediastinal lymphadenopathy was higher in William hall´s study than our study, which can be due to the difference between sample sizes (8).

The third category of imaging findings that do not require follow up and emergency care include aortic and coronary artery calcification, mitral valve calcifications and cardiomegaly. As it is appear the rate of aortic and coronary arteries calcification suggesting atherosclerosis, and also cardiomegaly is much higher in our study than William Hall ´s study (8). This can indicate more prevalence of atherosclerosis in Iranian patients that require further investigations. The frequency of mitral valve calcifications was 2% in our study whereas other similar studies did not investigate it.

The last finding that we evaluated and was not investigated in similar studies are the signs of right ventricular dysfunction. These findings are not included in other categories. It can be a complication of PE and it may worsen the prognosis or it can also be due to other heart diseases and it may or may not cause acute symptoms.

In a study that was performed by Foley *et al* in 2007, 100 CTPA examinations were investigated and PE was detected in 5% of patients (4). Incidental cardiovascular findings were also observed including aortic wall calcification (54%), coronary calcification (46%), atrial dilatation (18%), cardiomegaly (41%), mitral annulus calcification (15%), aortic dilatation (8%), right ventricular dilatation (11%), and right ventricular thrombus (1%). The other incidental findings were as follows: lung nodules (14%), pleural effusion (2%), lobar collapse /consolidation (8%), emphysema (6%), and pleural calcification (4%). This study showed that CTPA can demonstrate evidences of incidental pulmonary and cardiovascular pathology. Whilst these findings may not need immediate clinical management, they may be clinically relevant in long-term (4).

In another study conducted by Barclay and

colleagues at the Boston hospital, CTPA was performed in 97 patients from July 2004 to March 2008. In this study, 89 patients had PE and the two most common alternative diagnosis on PCTA were pneumonia (22 cases) and atelectasis (22 cases). In 17 patients pleural effusion was detected .This study suggested that systemic investigation is required for detecting PE as well as other diseases on CTPA in patients of suspected acute PE (14).

In another study, which was published by Rebecca in 2010, 589 patients of suspected PE were evaluated by CTPA; and only 9% of these patients had PE. In this study CTPA demonstrated accidental findings that require follow up including: lung nodules (73 cases), adenopathy (51cases), lobar infiltration (29 cases), multi lobar infiltration (37 cases), and pleural effusion (113 cases) (15).

Conclusion

PE is a major cause of morbidity and mortality. Many patients with an initial suspicion of PE will eventually be labeled with an alternative disease including pneumonia, lung cancer, aortic dissection and pneumothorax. Most of these diseases can be diagnosed on CTPA.

Radiologists sometimes report the presence or absence of PE and do not describe the other imaging findings. In these patients, a wrong diagnosis may occur by the clinician and the diseases that have not been reported by radiologist may also progress and diagnose at a later stage which can change the prognosis. On the other hand, when the clinical symptoms are not improved, another CT scan may be performed which is the most significant source of radiation exposure for the general population, while these non-embolic chest diseases can be diagnosed by CTPA, if they were considered and reported. Therefore, it is recommended that radiologists report the non-embolic findings, especially the imaging findings that can describe the acute clinical symptoms of the patient and also those that require further investigations or follow up.

Acknowledgment

This study was financially supported by the vice chancellery of research of Mashhad University of Medical Sciences, Mashhad, Iran This manuscript is part of the residency thesis of Seyed Hosein Faghih Sabzevari under the approval number of 910021.

Conflict of Interest

The authors declare no conflict of interest.

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