FREQUENCY OF CLINICALLY RELEVANT INCIDENTAL FINDINGS ON CHEST COMPUTED TOMOGRAPHIC ANGIOGRAMS PERFORMED TO DIAGNOSE PULMONARY EMBOLISM

Beenish Javaid,[1] Huma Saeed Khan,[2] Anum Shafique,[3] Tahira Iftikhar,[4] Mariam Asif[5]

ABSTRACT

Background and Objective: Patients with symptoms of suspected pulmonary embolism (PE) who undergo computed tomography (CT) pulmonary angiogram have other imaging findings in addition to PE in the pulmonary circulation. The radiologists must pay attention to these incidental findings and report them rather than just giving a positive or negative pulmonary angiogram report. Therefore, the objective of the study was to determine the frequency of clinically relevant incidental findings on CT angiograms in patients with suspected pulmonary embolism (PE).

Methods: It was a cross-sectional study conducted at the radiology Department of Hameed Lateef Hospital from May to November 2023. The study included 133 patients of both genders, with suspected pulmonary embolism. Patients with known tuberculosis, COPD, CRF and claustrophobia were excluded. Ensuring the protocols of informed consent, CT angiography of the chest was performed with and without intravenous contrast administration. The craniocaudal images at direction 25, 65, and 180 sec post-iodinated contrast injection during single breath hold were obtained. Results were interpreted for any clinically relevant incidental findings.

Results: Clinically relevant findings discovered incidentally in CT pulmonary angiograms were found in 78 (58.65%) patients. Of these, pulmonary nodule was found in 11 (14.10%), lymphadenopathy in 04 (5.13%), pleural effusion in 34 (53.59%) and consolidation in 29 (37.18%) patients.

Conclusion: The frequency of incidental findings which are relevant clinically is quite high in chest CT pulmonary angiograms performed to diagnose PE.

Key Words: Pulmonary Embolism, Incidental Findings, Computed Tomographic Angiograms.

Pulmonary embolism (PE) is a leading cause of morbidity and mortality. Reported cases in the United States alone account for approximately 300,000 cases per year.[1] High BMI, prolonged immobilization, smoking, malignancy, recent surgery, trauma, postpartum state, intake of contraceptives or hormone replacement therapies are major risk factors for PE. A positive history of PE or altered hemostasis are also included in the etiology list. However, 30% of patients with PE do not have any identifiable risk factors as reported in the Emergency Medicine Pulmonary Embolism in the Real-World Registry (emperor), International Cooperative Pulmonary Embolism Registry (ICOPER), and Registro Informatizado de Enfermedad Trombo Embólica (RIETE) registries. PE is usually diagnosed in the elderly, whose age is between 56 to 66 years, and this varies with gender as well, with females showing a relatively less prevalence.[2]

1,3-5.   *Department of Radiology, Hameed Latif Hospital, Lahore*
2.   *University of Health Sciences, Lahore*

Correspondence:
Dr. Beenish Javed, *Consultant Radiologist, Department of Radiology, Hameed Latif Hospital, Lahore.*
Email: beenish.adnan@live.com

The advent of computed tomography pulmonary angiography (CT-PA) has contributed as a revolutionary investigation for diagnosis of pulmonary embolism.[3] Compared to previously used diagnostic tools, CT-PA has proved its speed and reliability in excluding PE in patients with relevant symptoms. The demerits of this investigation are radiation exposure and a small risk (about 4%) of nephropathy because of the contrast.[4] The clinical features that the patients present with can be non-specific. Dyspnea, cough, hypotension, and hemoptysis are the usual presenting features in patients all of which overlap with other cardiovascular (CVS) and pulmonary disorders.[5] In previously reported studies, it was observed that infection and pleural effusion may be concomitantly present in many patients with PE, these being the two top differentials of PE.[6,7]

It has been observed that radiologists only emphasize the presence or absence of PE and skip other imaging findings. The objective of the study was to determine the frequency of clinically relevant incidental findings on chest computed tomographic angiograms requested to diagnose pulmonary embolism. The results of this study will promote the radiologists to report all the non-embolic findings that correlate with the acute clinical symptoms of the patient and others that require supplementary investigations or a programmed follow up. Accurate diagnosis may lead to proper management in these sets of patients, with the aim of reducing the burden of morbidity and mortality.

METHODS

It was a descriptive cross-sectional study, conducted at the Department of Radiology at Hameed Lateef Hospital from May to November 2023. Sample size was calculated by using the WHO sample size calculator, taking 95% confidence level and 8% margin of error. Percentage of incidental findings on CTPAs was taken as 32.7% as reported in a previously published study.[8] The sample size amounted to 133 cases. Non-probability consecutive sampling technique was employed to recruit the patients. The inclusion criteria were clinical symptoms of pulmonary embolism (described in operational definition), duration of symptoms <24 hours, age between 20-50 years in both genders. The exclusion criteria were as follows: patients diagnosed with tuberculosis, COPD, cancer, chronic renal or liver diseases and with fear of closed spaces. Operationally, clinically suspected pulmonary embolism was considered in patients who presented with following symptoms and signs: sudden difficulty in breathing and chest pain (assessed on history), respiratory rate >30/min, heart rate >100/min and blood on coughing.[9] Pulmonary embolism was considered on CTPA when on pulmonary angiography, vessels appear white and emboli appear dark.[10] Clinically relevant incidental findings on CTPA were considered positive if one of the following was observed: Pulmonary nodule; presence of irregular, lobulated and spiculated border and enhancement of greater than 20 HU was taken as positive;[11] Adenopathy: presence of rounded, hypoechoic nodes with or without central necrosis, extracapsular invasion and size >10 mm was taken as positive.[12] Pleural effusion: presence of opacity along chest walls with attenuation similar to that of fluid was taken as positive,[13] and Consolidation: presence of ground glass opacities with increased haze and reticulonodular opacity with peribronchial thickening and thickening of interlobular septa was taken as positive.[14] A person was considered a smoker if there was a history of smoking >10 cigarettes / day for >2 years.[15]

After obtaining approval by the institutional ethical review committee, 133 patients presenting to Radiology section of Hameed Latif Hospital, Lahore, were selected. They met the inclusion criteria. Once an informed consent was taken, CTPA was performed on Toshiba Aquilion Multislice CT scanner. The images were recorded before and after administration of a contrast. Images were acquired in sets of three in a craniocaudal direction at 25s, 65s, and 180s post contrast, using single breath hold technique. Results were assessed by a senior radiologist (possessing a post fellow ship practical experience of at least 3 years) for any clinically

relevant incidental findings (yes/no). All data regarding (age, gender, duration of symptoms, smoking (yes/no), residing addresses, occupation and clinically relevant incidental findings) were recorded via a self-administered questionnaire (Annexure-I). Utilizing the computer software (SPSS 20.0), the collected data were analyized. Age and duration of symptoms were reported as mean and standard deviation. Frequency and percentage calculations were carried out for gender, history of smoking, residence, occupational status and clinically relevant incidental findings i.e. pulmonary nodule, lymphadenopathy, consolidation and pleural effusion. Stratification was performed for age, gender, duration of symptoms, smoking, residential information and occupation. The chi square test was used to assess the relationship of age, gender and duration of symptoms with clinically relevant incidental findings. A p-value ≤0.05 was considered significant.

RESULTS

The study participants presented with diverse age groups, spanning 20 years to 50 years. Mean age was calculated at 39.36 ± 6.84 years. Major bulk of the study participants, 94 out of 133 (70.72%) fell in the age bracket of 36-50 years. Based on gender, it was reported that 82 (61.65%) males and 51 (38.35%) females participated in the study (ratio 1.6:1) Mean duration of the symptoms of the disease was 9.56 ± 4.31 hours. Tabulated data of patients according to independent variables is shown in table 1.

The analysis of the current study showed a frequency of clinically relevant incidental findings in 78 (58.65%) patients. Amongst these 78 patients, pulmonary nodule was found in 11 (14.10%), lymphadenopathy in 04 (5.13%), pleural effusion in 34 (53.59%) and consolidation in 29 (37.18%) patients as depicted in table 2. Chi square test was applied on age gender and clinical symptoms. Nonsignificant statistical difference was revealed for age and gender. Comparison of clinically relevant incidental findings with respect to duration of symptoms revealed no significant difference between groups (p-value=0.623) as shown in table 3.

Table 1: *Tabulation of patients according to independent variables (n=133)*

Confounding variables		Frequency (n)	%
Smoking	Yes	57	42.86
	No	76	57.14
Occupation	Office	41	30.83
	Field	27	20.3
	Factory	45	33.83
	Others	20	15.04
Residential status	Rural	81	60.9
	Urban	52	39.1

Table 2: *Distribution of suspected pulmonary embolism patients with different incidental findings on chest computed tomographic angiograms (n=78).*

Findings	No. of patients (n)	%
Pulmonary nodule	11	14.1
Adenopathy	4	5.13
Pleural effusion	34	53.59
Consolidation	29	37.18

Table 3: *Clinically relevant incidental findings with respect to duration of symptoms(n=78).*

Duration of symptoms	clinically relevant incidental findings (n)		p-value
	Yes	No	
<12 hours	61	41	0.623
≥12 hours	17	14	

DISCUSSION

CTPA is the test of choice preferred by radiologists, however it has its own risks and complications.[16] The PIOPED II trial has demonstrated that CTPA has a high sensitivity (83%) and specificity (96%). The positive predictive value of diagnosis of PE can be as high as 96% when CTPA is combined with relevant history and clinical examination.[17] PE is diagnosed on CTPA by the presence of radiological signs such as the "polo mint appearance" and the "railway sign" depending on the central filling defect in the pulmonary vessels and the angle of view. Large emboli may be seen over the bifurcation of the pulmonary trunk and are referred to as "saddle emboli".[18] Pulmonary infarct which occurs after acute PE is seen as a wedge-shaped opacity with a

"reverse-halo" or "atoll" appearance, which is a central ground glass with rim of consolidation. Pleural effusion may also be an incidental finding in patients with acute PE.[19] Parenchymal changes in chronic PE include mosaic perfusion, band-like opacities, and bronchial dilation.[20]

The aim of this study was to determine the frequency of clinically relevant incidental findings on CTPAs. The age bracket was 20 to 50 years, and the tabulated mean age was 39.36 ± 6.84 years. Ninety-four patients (70.72%) were between 36 to 50 years of age. Male to female ratio remained 1.6:1, out of 133 patients, of whom 82 (61.65%) were males and 51 (38.35%) were females. The current study found clinically relevant incidental findings in 78 (58.65%) patients. Out of these 78 patients, pulmonary nodule was found in 11 (14.10%), lymphadenopathy in 04 (5.13%), pleural effusion in 34 (53.59%) and consolidation in 29 (37.18%) patients.

Eskandari et al.[7] reported 74.5% of the patients in their study had at least one incidental finding. Type 1 incidental findings (alternate diagnosis to PE) were found in 864 patients (41.5%).[7] In another study, new incidental finding was found in 61.1% with consolidation in 32.7% and pleural effusion in 51.6% patients.[21] Goodman[22] has reported that patients who present with a set of symptoms in hospital require a plausible explanation for their clinical state. The reason for increased utilization of pulmonary CTPA is due to its ability to recognize alternate diagnoses that may warrant emergency action (4). Moreover, even a "negative" study has profound clinical importance in patients with different comorbidities. In contrast to the current findings, some studies debate about the relevance of an alternate diagnosis.[23] Chandra et al[24] researched that CTPA contributed to a previously undiagnosed alternative diagnosis, e.g pneumonia, in only 7.6% of patients.

A retrospective cohort,[25] that included 1629 CT's (mean patient age was 62 ± 16.7 years, of which 56.9% were female, having a median CTPA score of 2), concluded that PE was reported in only 233 (14.3%) out of these 1629 CT's. One hundred and seventy-three (10.6%) CT's detected an observation supporting an alternate diagnosis. Out of these 173, pulmonary infiltrates were reported to be the highest (n=130, 75.1%). In a subgroup of patients (116 patients amounting to 77.1%) who underwent both CTPA and chest x-ray (CXR), the X-ray alone would sufficiently have provided an alternate diagnosis. A total of 223 (13.6%) patients had an incidental observation; with preponderance of pulmonary nodules (n=83, 37.2%) and lymphadenopathy (n=26, 11.6%). It conceded that only 26 (17.1%) incidental imaging observations were of significance; most prevalent included pulmonary nodules (n=6, 3.9%) and masses (n=7, 4.6%) that ultimately ended in biopsies cumulating to lung cancer diagnoses. An additional 301 follow-up CTs were prompted by these incidental findings with a yield outcome of 9.2% (n=48 CTs) that was pretty significant.[25] This study has several limitations. It was conducted at a single center, which limits the generalizability of the findings to other healthcare settings. The sample size was relatively small (n=133), which may affect the statistical power and robustness of the results. The use of non-probability consecutive sampling introduces a potential for selection bias. The restricted age range of 20–50 years excludes older patients, in whom pulmonary embolism is more prevalent. Excluding patients with comorbidities such as tuberculosis, COPD, cancer, and chronic organ diseases further limits the applicability of findings to the broader population. All scans were interpreted by a single radiologist, which introduces the risk of observer bias, and no inter-observer reliability was assessed. The absence of comparison with other imaging modalities limits the validation of incidental findings. In the future, similar studies should be done in different hospitals and include patients of all age groups. It would also be helpful to follow patients over time to see how these incidental findings affect their treatment and health.

CONCLUSION

The results of the current study concluded that CTPAs requested to rule out PE often uncover an alternative finding with a remarkably high frequency, that is still clinically relevant and explanatory for patients' symptoms. Based on the discussion and research results, we recommend that radiologists should just not give a positive or negative angiogram report, rather should report all the non-embolic findings that can help the clinician to interpret the acute patient symptoms and also

isolate the cases that require supplementary investigations or a scheduled follow up. In short, it will help the clinician to reduce the morbidity and mortality and save the patient from the financial and ionizing radiation burden of repeated investigations.

Ethical Approval

Approval was obtained from institutional ethical review committee of Hameed Latif Hospital vide reference letter no. HLH/ADM/IRB/2023-02.

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Author's Contribution

All authors read and approved the final draft.

Conceptualization study design	BJ, HSK
Data Acquisition	BJ, AS, TI
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