

## COMPUTED TOMOGRAPHY PULMONARY ANGIOGRAPHY FOR DIAGNOSIS OF PULMONARY EMBOLISM

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### Contribution

TN conceived the idea and designed the study. TA did data collection and manuscript writing was done by TS. NN did final review. All authors contributed equally to the submitted manuscript.

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### ABSTRACT

**Objective:** To study the role of Computed Tomography Pulmonary Angiography in the detection of pulmonary embolism.

**Methodology:** This retrospective observational study was performed in Radiology Department, Lady Reading Hospital, Medical Teaching Institute, Peshawar, Pakistan, from July 2017 to December 2018. Computerized clinical and diagnostic record of patients referred for CT Pulmonary Angiography (CTPA) to radiology department for the diagnosis of pulmonary embolism (PE) were retrieved from the e-log and retrospectively analysed. Patients referred for CTPA with suspicion of PE were included in the study. Patients undergoing CTPA for conditions other than PE were excluded from the study.

**Results:** Amongst the total of 117 patients, 52 were males. Age range was from 10-100 years with a mean age of 51 years. A total of 74 out of 117 patients (63.2%) were reported negative for PE while 43 cases (36.8%) were reported positive for PE. The most common patient presentation was shortness of breath (58.1%) and commonest risk factor was deep vein thrombosis (DVT) (20.9%).

**Conclusion:** CTPA is a minimally invasive fast technique for the detection or exclusion of pulmonary embolism. It is an investigation of choice having a high sensitivity and specificity in symptomatic patients with identifiable risk factors. Its availability is mandatory in tertiary care hospitals for early accurate diagnosis giving a road map for prompt patient management.

**Key Words:** CTPA, Pulmonary embolism, Multi-detector CT.

## INTRODUCTION

Pulmonary thromboembolism (PTE) is the one of the commonest acute cardiovascular diseases after myocardial infarction and stroke and is associated with high early mortality rates. PE can result in right ventricular (RV) failure, which is a life threatening condition, however, urgent management can prevent mortality. The patient presentation is variable ranging from asymptomatic to shock or sudden death. The most common presenting symptom is dyspnoea followed by chest pain and cough.<sup>1-3</sup>

PTE and deep vein thrombosis (DVT) is associated with multiple risk factors and comorbid conditions. These include patient age, active malignancy or other disabling conditions such as heart or respiratory failure, recent major trauma, fracture or surgery, congenital or acquired coagulation disorders, use of hormone replacement therapy (HRT) or oral contraceptives.<sup>2,4</sup> Patients older than 40 years of age are at increased risk of having PE and the risk is almost doubled with each decade.<sup>4</sup> DVT is the commonest source of PE followed by iliac, renal vein and IVC thrombosis.<sup>2,3</sup> As part of cardiovascular disease spectrum, other common risk factors include cigarette smoking, obesity, hypercholesterolemia, hypertension and diabetes mellitus.<sup>4</sup>

Diagnostic tests for PTE include chest X-ray (CXR), ventilation perfusion scan, CTPA, MR- pulmonary angiogram (MRPA), echocardiography and catheter pulmonary angiogram. Amongst all of these the use of CTPA in patients with suspected PTE has increased significantly. Ventilation perfusion scan is reserved for cases where IV contrast administration is contraindicated. D-dimer assay is useful for ruling out venous thromboembolism in low risk patients.<sup>5</sup>MRPA also provides accurate diagnosis but has limited availability and is a time consuming procedure.<sup>6</sup>

Accurate and reliable diagnosis of PE is crucial for timely patient management.<sup>7</sup>Nowadays, CTPA is the established modality of choice due to its minimally invasive nature, easy availability and high sensitivity and specificity (90 and 95% respectively).<sup>1,7,9</sup>Invasive pulmonary angiography is the gold standard investigation for PTE, however due to its complications, high mortality rate (0.5%) and invasiveness, its use is limited.<sup>9</sup> The purpose of this study is to share the initial

experience in our hospital and to highlight the role of CTPA as the primary imaging modality of choice for suspected pulmonary embolism.

## METHODOLOGY

This retrospective observational study was performed in Radiology Department, Lady Reading Hospital, Medical Teaching Institute, Peshawar, Pakistan over a period of 17 months, from July 2017 to December 2018. Computerized clinical record of patients of CTPA were retrospectively analysed. Patients of all ages and both genders who were referred by the physicians, presenting with clinical findings suggestive of pulmonary embolism (PE) were included in the study. Patients undergoing CTPA for conditions other than PE were excluded from the study.

CTPA was performed on 160 slice multi-detector CT scanner (AQUILON PRIME 160 TOSHIBA, JAPAN). During the imaging procedure, the patient was asked for a single breath hold in the supine position for 10 seconds after inspiration. Scan volume included the entire thoracic cage, rib to rib and from lung base to apex in caudo-cranial direction. The caudo-cranial technique was used to avoid artefact from superior vena cava (SVC). The detector scan area was 40mm with slice thickness of 0.5 mm, 120 V tube voltage and automatic exposure control (AEC) was used. Ultravist 300 (or 370)was used as contrast medium and injected into the antecubital vein during procedure at flow rate of 4-5mL/s. Data was achieved and images were viewed on Vitrea workstation including axial, coronal and sagittal sections. Scans were interpreted on mediastinal, lung and specific pulmonary vascular windows. For each lung, main, lobar, segmental and sub-segmental arteries were examined for pulmonary embolism.

## RESULTS

Out of 117 patients, 52 were male and 65 were female. Age range was from 10-100 years with a mean age of 51 years (Table1). About 74 out of 117 patients (63.24%) were reported negative for PE while 43 cases (36.76%) were reported positive for PE (Table 2). The most common patient presentation was shortness of breath (Table 3) and commonest risk factor was DVT (Table 4).

**Table 1: Demographics of the patients (n=117)**

| Variable | Frequency (n) | Positive for PE |
|----------|---------------|-----------------|
| Male     | 52            | 18              |
| Female   | 65            | 25              |
| Total    | 117           | 43              |

**Table 2: Diagnosis based on CT Pulmonary Angiogram (n=117)**

| Cases           | Percentage(%) | Frequency (n) |
|-----------------|---------------|---------------|
| Negative for PE | 63.24         | 74            |
| Positive For PE | 36.76         | 43            |
| Total           | 100           | 117           |

**Table 3: Clinical presentations of PE positive patients (n=117)**

| Presentations   | Frequency n=43 | Percentage (%) |
|-----------------|----------------|----------------|
| SOB             | 25             | 58.1           |
| Chest pain      | 6              | 13.9           |
| Hemoptysis      | 3              | 6.9            |
| Cough           | 2              | 4.6            |
| Pneumothorax    | 1              | 2.3            |
| Epigastric pain | 1              | 2.3            |
| Palpitations    | 1              | 2.3            |

**Table 3: Risk factors of PE positive patients (n=117)**

| Risk Factors   | Frequency n=43 | Percentage (%) |
|----------------|----------------|----------------|
| DVT            | 9              | 20.9           |
| HTN            | 7              | 16.3           |
| Post op state  | 5              | 11.6           |
| DM             | 4              | 9.3            |
| Post partum    | 3              | 6.9            |
| Cardiomyopathy | 2              | 4.7            |
| Fractures      | 2              | 4.7            |
| Lymphoma       | 1              | 2.3            |
| Smoking        | 1              | 2.3            |
| CLD            | 1              | 2.3            |
| CKD            | 1              | 2.3            |

## DISCUSSION

CTPA is the imaging modality of choice for detection or exclusion of pulmonary embolism in modern clinical practice. Multi detector CTPA has sensitivity and specificity ranging from 83% to 100% and from 89% to 96% respectively. Advantages of CTPA are high sensitivity and specificity, quick result turnout, detection of associated complications and widespread availability. Associated complications can be pulmonary arterial hypertension, right ventricular (RV) failure and pulmonary infarcts.<sup>1,10</sup>

The disadvantages are high cost, increased radiation dose and contrast use.<sup>11</sup> Indeterminate suspicious cases require supportive investigations in the form of lower limb Doppler, D-Dimers, CXR and V/Q scan. Reasons for an indeterminate CTPA study include limitations due to respiratory motion artefact, streak artefact, extensive pulmonary parenchymal findings and poor opacification of the pulmonary arteries.<sup>12</sup>

CTPA can also provide an alternative treatable diagnosis in patients whose scans prove to be negative for pulmonary embolism.<sup>13,14</sup> In our study alternate diagnoses in patients whose scans were negative for PE included pneumonia, interstitial lung disease, pulmonary edema, pulmonary metastasis, pleural

effusion and hypoplasia of unilateral pulmonary artery were made in patients presenting with acute SOB and having predisposing factors of PTE.

Diagnostic criteria for acute pulmonary embolism include

- 1) Failure of enhancement of entire arterial lumen with contrast resulting in filling defect.
- 2) The artery may be enlarged compared to the adjacent patent vessels.
- 3) Partial filling defect on sections perpendicular to the long axis of the artery forming "polo mint" sign
- 4) "Railway track" sign on longitudinal images.
- 5) Peripheral intraluminal filling defect forming acute angle with the arterial wall.

In the event of re-canalization in chronic pulmonary embolism, the thrombosis will give the appearance of partial filling defect with webs and flaps and forming an obtuse angle to vessel wall contrary to acute thrombus which forms acute angle (Figure 1-4). Peripheral wedge shaped infarcts may be visualised on lung window. RV strain or failure is optimally monitored on echocardiography, however it can be quantified on CTPA as well allowing for early detection and early implementation of

appropriate treatment. It is represented by wider RV cavity diameter than left ventricular (LV) cavity in short axis and deviation of interventricular septum towards left ventricle. The prime responsibility of a radiologist is to determine whether images are of optimum quality and presence or absence of pulmonary embolism. In-case of poor image quality, the radiologist needs to determine which vessels are indeterminate and if scan repetition is required.<sup>6,15</sup>

In our study 117 patients were referred by clinicians for CTPA to diagnose/exclude PE based on their clinical presentation, however only 43 cases (36.8%) turned out to be positive for PE. The reason being non-specific presentation of pulmonary embolism that often causes diagnostic uncertainty. The most common symptom in our study was shortness of breath (58.1), followed by chest pain (13.9) and haemoptysis (6.9). Other less common presentations included cough (2.3%), palpitations epigastric pain (2.3%) and pneumothorax (2.3%). Various risk

factors for PE were present in patients included in our study. The most common risk factor in PE positive patients was DVT (20.9%) followed by hypertension along with other comorbidities (16.3%), post-op status (11.6%), diabetes mellitus (9.3%) and post-partum state (6.9%). Less common factors included cardiomyopathy (4.7%), fractures (4.7%), lymphoma (2.3%), smoking (2.3%) CLD (2.3%) and CKD (2.3%).

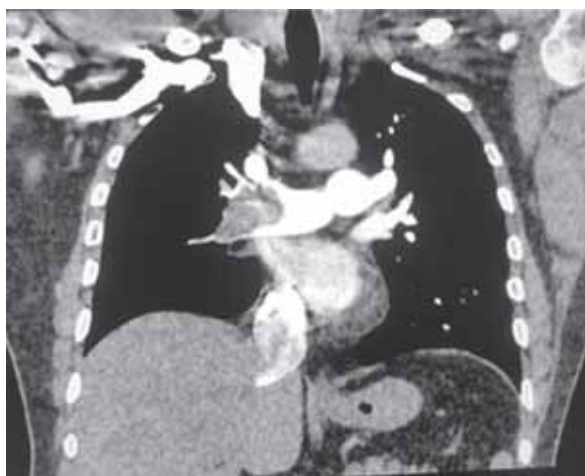
## CONCLUSION

CTPA is a minimally invasive fast technique for the detection or exclusion of pulmonary embolism. It is an investigation of choice having a high sensitivity and specificity in symptomatic patients with identifiable risk factors. Its availability is mandatory in tertiary care hospitals for early accurate diagnosis giving a road map for prompt patient management.

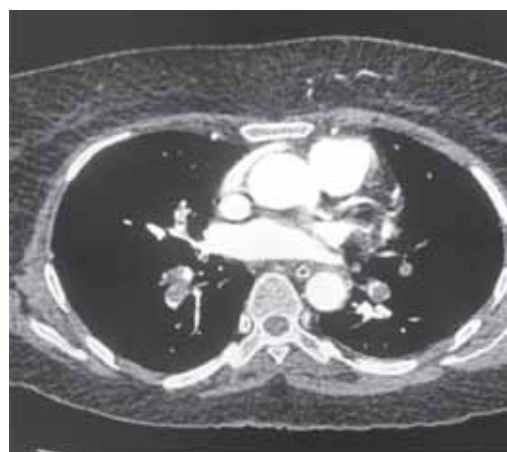
**Figure 1: Normal CTPA**



**Figure 3: Right Pulmonary Artery Embolism (Coronal Image)**



**Figure 2: Bilateral Lobar Pulmonary Artery Embolism**



**Figure 4: Complete Embolism Right Pulmonary Artery**



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