



Original article

**The value of hyperdense lumen sign at non-contrast Computed Tomography in the diagnostic work up of Pulmonary Embolism**

Samuel Magdy Shafik, Ahmed Hesham Mohamed Said, Faten Mohamed Ali

Radiology department, Faculty of Medicine, Beni Suef University, Egypt

Article Info

Abstract

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**Corresponding Author:**

Samuel Magdy Shafik

[smagdy91@gmail.com](mailto:smagdy91@gmail.com)

**Keywords:**

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computed tomography.

**Background;** It is possible to identify high-attenuation clots in pulmonary thromboembolism using non-contrast computed tomography (CT) of the chest. Such detection may be crucial for timely initiation of appropriate therapy. **Aim and objectives;** the aim of this study was to show the accuracy and usefulness of non-contrast CT in diagnosis of pulmonary embolism. **Subjects and methods:** The study was conducted in the Radiology Department at Beni-Suef University hospital to evaluate the role of non-contrast multi-slice computed tomography (MSCT) in detection of central pulmonary embolism using 16 slice MDCT. **Result;** hyperdense lumen sign shows an overall sensitivity of 50%, specificity of 100%, PPV (positive predictive value) of 100% while the NPV (negative predictive value) was 65.4%, having diagnostic value in detection of emboli which are located within the main pulmonary arteries, and the high-attenuated emboli (hyperdense sign) in pulmonary artery had a sensitivity of 50 % and regarding the specificity was 100% for diagnosis of PE. **Conclusion:** Positive hyper dense lumen sign can be prominent indicator of thrombus, which can be relied upon if (Computed Tomography Pulmonary Angiography) CTPA is not possible.

## **1. Introduction:**

Pulmonary Embolism (PE) is the blockage of the main pulmonary artery or its branches by substance that has traveled from elsewhere in the body through the blood stream. [1]

Acute PE has an annual incidence of approximately 3-6 cases/10000 in general population. [2]

Pulmonary embolism is known to be a leading cause for patient morbidity and mortality. It is hard to establish the diagnosis of pulmonary embolism based on the clinical data of the patient as its symptoms and signs are usually nonspecific and may be asymptomatic as well [3].

The introduction of the spiral Computed tomographic (CT) angiography modality significantly improved the diagnostic plan for detection of pulmonary embolism [4]. After suspecting PE, clinically, patients go for Computed Tomography Pulmonary Angiography (CTPA) which is considered to be the gold standard modality for imaging diagnosis of PE [5].

An acute PE can occasionally be detected as high attenuated emboli (hyperdense lumen sign) in the pulmonary artery on unenhanced CT. [6] So the ability of radiologist to establish an accurate diagnosis of PE based on MDCT information may be helpful in a situation when CTPA can't be performed or isn't available. [7]

The aim of this study was to show the accuracy and usefulness of non-contrast CT in diagnosis of pulmonary embolism.

## **2. Patients and Methods:**

The study was conducted in the Radiology Department at Beni-Suef University hospital to evaluate the role of non-contrast multi-slice computed tomography (MSCT) in detection of central pulmonary embolism using 16 slice MDCT.

In the period between 12-2020 and 6-2021, thirty –five (35) patients were included in the study (16 males & 19 females their age ranged from 18 to 80 years), which were referred from emergency department, ICU and the chest department in Beni-Suef University hospital.

**Inclusion criteria:** Age group between 18 and 80 years old. Patients who are clinically or laboratory suspected PE: Clinical symptoms were: dyspnea, chest pain, tachypnea, tachycardia or hemoptysis, patients who have scored more than 4 (regarding Wells' score). D-Dimer was the main laboratory investigation done.

**Exclusion criteria:** As exclusion criteria of all x-rays radiation such as pregnancy with low degree of suspicion, patients who are unstable from a respiratory status requiring immediate ICU admission and patients who has hypersensitivity to contrast material.

### **Method of the study:-**

Upon the Ethical committee, Faculty of medicine- Beni Suef University's, approval

no. FMBSUREC/03012021/Shafik was granted.

**All patients included in the study were subjected to the following:** Informed written consents were taken before CT examination Proper history taking and identification of clinical presentation. Imaging procedure: MDCT (pre and post contrast) with post processing MDCT techniques.

**Preparation:** All patients with normal serum creatinine level (up to 1.4 mg/dL level) were fasting for 6 hours before the examination. The procedure was explained to the patient, followed by reassurance. The patient was placed supine on the CT table with their arms above the level of their heads and instructed to hold breath and not to move during the scan.

**Pre-contrast CT imaging of the chest was obtained.**

Automated injector (some of them were Dual-head) was connected to a previously placed antecubital vein cannula.

A scanogram of the chest and upper abdomen was obtained.

The scanning started from the supra aortic trunks to the base of lungs.

After we obtain the image, we measure any hyperdense segment (HU more than 72) found in the lumen of the main pulmonary artery, right and left pulmonary arteries.

**CT Angiography Examination:-**

**Scanning parameters:-**

**The contrast material was administered as follows:** injection of 80 ml of non-ionic low

osmolar contrast material (**LOCM**) (1.2 ml /kg body weight) with an automated injector at a flow rate of 4.5 ml/sec. Transverse sections were reconstructed on a workstation with a section width of 1.25 mm. The images are displayed with three different gray scales for interpretation of lung window (window width, 1,500 H; window level, -600 H), mediastinal window (window width, 350 H; window level, 40 H), and pulmonary embolism-specific (window width, 700 H; window level, 100 H) settings.

The pulmonary embolism-specific settings also help to differentiate between a sharp margined embolus and an ill-defined artifact. However, modified window settings can also increase the conspicuity of artifacts caused by image noise and flow.

**Post-processing:** The raw data were processed using Maximum Intensity Projection (**MIP**), Volume Rendering and Shaded Surface Display. Maximum Intensity Projection (**MIP**) is necessary to mark bone structures on all images for removal, then **MIP** images are created in coronal and oblique views to allow maximum vessels visualization.

**Data acquired:** Detection of hyper dense lumen sign in the pre contrast CT and comparing it with CTPA findings. Distribution of the embolus into the pulmonary tree

**Statistical Analysis:**

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 23.

The qualitative data were done by using Chi-square test and Fisher exact test instead of the Chi-square only when the expected count in any cell was found less than 5.

Receiver operating characteristic curve (ROC) was used to assess the diagnostic accuracy with sensitivity, specificity, positive predictive value and negative predictive value.

### 3. Results:

Our study included 35 patients who presented to the departments of radiology at Beni-Suef university hospital with highly suspected pulmonary embolism & CT pulmonary angiography and pre contrast CT chest were done for them at same session.

The study was conducted over a period of 6 months, from 12-2020 and 6-2021

**Table 1:** The clinical presentation among the studied patients. Dyspnea was found to be the most common presenting symptom, while hemoptysis is the least common one.

Associated Clinical symptoms	No.	%
Chest pain	19	54.3%
Dyspnea	23	65.7%
Tachypnea	9	25.7%
Hemoptysis	5	14.2%
Tachycardia	7	20.0%

**Table 2:** The Distribution of thrombus among the studied patients, based on the CTPA, the

highest incidence is at the right pulmonary artery.

Site of pulmonary thrombus	No.	%
Right pulmonary artery	8	44.4%
Left pulmonary artery	3	16.6%
Bilateral	7	38.8%
Total	18	100.0%

**Table 3:** Comparing positive results between CTA and non-contrast CT in detection of central pulmonary embolism.

Imaging modality		No.	%
CTPA	Positive	18	51.5%
Non contrast CT	Positive	9	25.7%

**Table 4:** Illustrates diagnostic accuracy of non-contrast MDCT in detection of central pulmonary embolism in our study.

Parameter	Non contrast CT
TP	9
TN	17
FP	0
FN	9
Accuracy	74.3%
Sensitivity	50%
Specificity	100%
PPV	100%
NPV	65.4%

**Table 5:** shows the range of the thrombus density and the normal range of the surrounding blood density in this study.

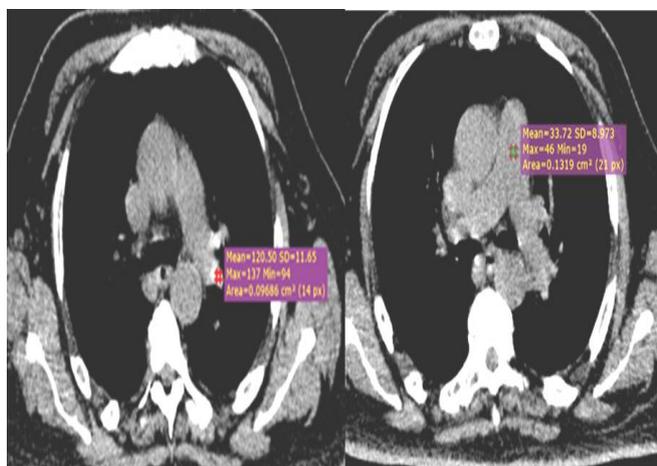
	From	To
Normal blood density	28 HU	42 HU
Hyperdense thrombus	72 HU	128 HU

Using of thin section reconstruction (1-1.5 mm), in this study it was 1.25 mm, was helpful in overcoming the problem of the partial volume artifact.

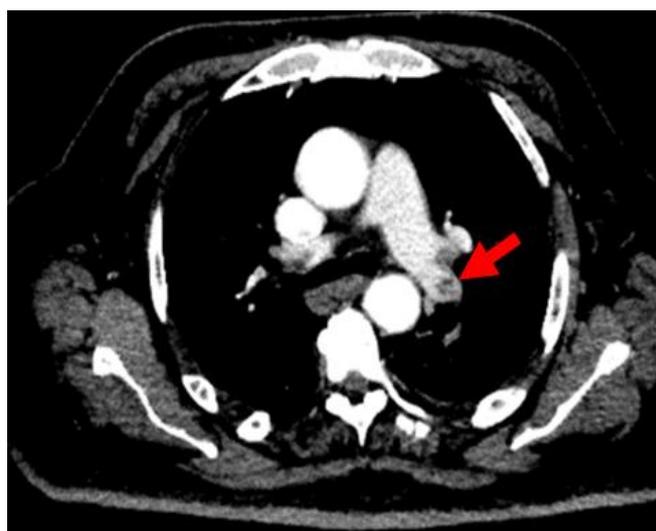
**Case 1:**

**History:** 70 years old male patient complaining of chest pain.

**By non-contrast CT:** Left pulmonary artery hyperdense lumen sign.



**By CTPA:** Left pulmonary artery filling defect.



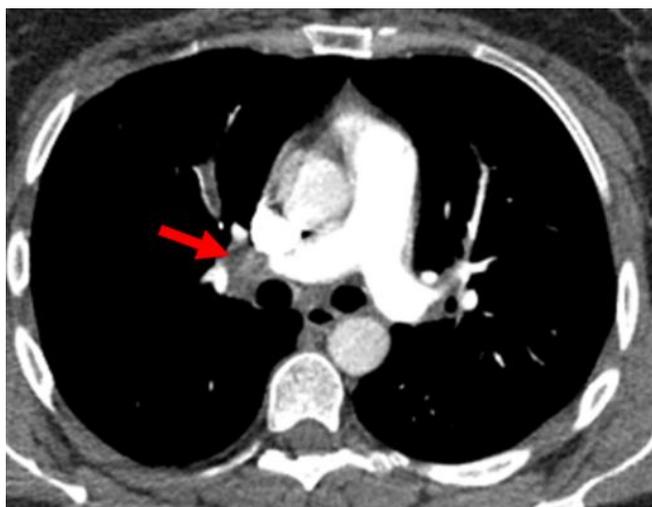
**Case 2:**

**History:** 42 years old female patient complaining of dyspnea and tachycardia.

**By non-contrast CT:** No hyperdense lumen sign seen.



**By CTPA:** Right pulmonary artery filling defect.



#### 4. Discussion:

As acute PE is considered a critical medical condition which could lead to death so accurate diagnosis in a short time may be lifesaving. CTPA, despite being the gold standard diagnostic tool, maybe not available or even contraindicated in some patients.

Detection of PE located in central pulmonary arteries is considered as a vital issue, as any obstruction at this level will significantly compromise the central perfusion leading to sudden death.

The age of patients ranged from 18 to 80 years old. The female patients representing the majority of our cases represented by 19 patients (54.3 % of the cases), female patients were also predominant [8, 9] in which studies with 60% and 57 % incidence respectively, matched with our study.

Clinical presentation of the patients was: 23 patients complained from **dyspnea** (65.7 %),

19 complained from acute **chest pain** (54.3 %), 9 patients complained from **tachypnea** (25.7 %).

Those reported result in our study agreed with the results came in **Crichlow et al.** [10] which showed that the most common presenting complain was shortness of breath (77%) of the total cases, followed by chest pain (74.3%)..

Regarding the number of positive cases, reported results in our study are found to be higher in comparison to the results by other previous studies. In **Perrier et al.** [8] study, the thrombus were found at: main pulmonary arteries in 60 of the patients out of 187 patient (32%), while in another study by **Pulido et al.** [12], out of 144 cases, only 21 had shown PE within the main-stem of the pulmonary artery tree (14.6%).

As regards the density of the thrombus seen in the non-contrast studies and the density of the normal blood pool, in our study the range of the hyperdense thrombus was varying from 72 to 128 HU, while the density of the normal surrounding blood pool was varying from 28 to 71 HU. These results was similar to the ones came by **Mohamed et al.** [13] which shows range from 65 to 150 HU for the hyperdense thrombus while the density of the blood was ranging from 20 to 60 HU.

According to our study, hyperdense lumen sign shows an overall sensitivity of 50%, specificity of 100%, PPV (positive predictive value) of 100% while the NPV (negative predictive value) was 65.4%, having

diagnostic value in detection of emboli which are located within the main pulmonary arteries.

Our study showed that the high-attenuated emboli (hyper-dense sign) in PA had a sensitivity of 50 % and regarding the specificity was 100% for diagnosis of PE, which is similar to the results came by **Mohamed et al.** [13] which revealed 50% sensitivity of the hyperdense lumen sign and 98.6% specificity.

## 5. Conclusion:

CTPA was the method of choice, in our study, for detection of central pulmonary embolism cases of high suspicion for pulmonary embolism. Comparing it with pre contrast study enables us to identify the reliability and validity of non-contrast CT scan in detection and evaluation of pulmonary aretry embolism. Our study revealed that positive hyper dense lumen sign can be prominent indicator of thrombus, which can be relied upon if CTPA is not possible.

The door is still open for further studies, taking in consideration other modifying factors such as D-Dimer, hematological studies and possibly other images modalities such as dual beam CT.

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