ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com
Journal DOI: 10.21474/IJAR01

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Prognosis Of Pulmonary Embolism In The Era Of Multislice CT Pulmonary Angiography.

Ghada A Abdel monem, Mai E.M. Khamis*, Enass M Khattab, Shimaa Farouk Abdelhai, Ayman R Abdelhai.

Manuscript Info

Manuscript History:

Received: 11 April 2016
Final Accepted: 13 May 2016
Published Online: June 2016

Key words:

Corresponding Author

Mai E.M. Khamis.

Abstract

Introduction:-

Pulmonary embolism (PE) is a probably lethal condition that can lead to morbidity and mortality in untreated patients. Early and precise diagnosis of PE significantly affects the patient outcome [(1)] .There are many developed clinical algorithms used for diagnosis of PE, that are based on negative results of a D-dimer test, which is very sensitive, however non specific method in excluding PE. Yet, there is an essential need for an imaging modality when PE is in doubt[(2)].

Unfortunately, till now the methods of its diagnosis have significant drawbacks. Plain radiographic findings are insensitive in diagnosis of pulmonary embolism. The ventilation-perfusion scan has low accuracy, with large differences in interpretation, especially in classification of low or intermediate probability scans [(1)]. Conventional pulmonary angiography is accurate and sensitive in confirming diagnosis of PE, however it is invasive, expensive and. Moreover, it is not commonly ordered by the clinician, owing to the relatively high morbidity associated with it (about 6%), especially in this critical disease [(3)].

Multi-detector computed tomography (MDCT) is a rapid, efficient and non-invasive imaging tool in diagnosis of pulmonary embolism. MDCT has multiple advantages, because its capability to encompass a large anatomic volumes with high spatial resolution. Additionally, shorter breath-hold times are beneficial in imaging of patients suspected of having PE and underlying lung disease. So, it has the capability to replace ventilation-perfusion scanning and conventional angiography and to improve the diagnosis and outcome of patients with pulmonary embolism [(4)].

Therefore, the aim of this study was to prospectively evaluate the accuracy of CT pulmonary angiography (CTPA) and quantitative cardiovascular CT parameters for accurate early diagnosis and predicting outcome in patients with acute pulmonary embolism.

Patients and Methods:-

1.Study design:-

This study was outlined as a prospective diagnostic and outcome study. It was approved by the ethics committee of our faculty. The treated physician informed the patients about the protocol and follow-up.

2.Patients:-

Between January 2015 and December 2015, 25 consecutive out patients who presented to the emergency department of the internal medicine and cardiology departments were included based on the clinical suspicion of PE characterized as exacerbating or acute onset shortness of breath, chest pain with no other evident etiology. Patients were excluded if they had a hypersensitivity to contrast medium, if a suspicion of PE was raised over 24 hours after admission, in the event that they were accepting anticoagulant treatment for other causes (e.g., atrial fibrillation), or, impeded renal function (creatinine clearance under 30 mL/min), hemodynamic instability, pregnancy, or inaccessibility for follow-up. Demographic and clinical characteristics, including age, heart rate, respiratory rate, systolic blood pressure and diastolic blood pressure of all patients were obtained on admission to the emergency department. Arterial blood gas sampling was performed, and the ratio of arterial oxygen tension to inspired oxygen fraction (PaO2/FiO2) was calculated. A 20-mL blood sample was taken and an intra-venous line was established shortly after admission to the emergency department. The presence of DVT was detected by lower extremity Doppler sonography.

3.Diagnostic Strategy:-

3.1.Clinical probability of PE was evaluated utilizing the simplified, revised Geneva score [5,6] or the 2-level Wells score for PE[7,8] **(Table 1)**. If the patient had a high or a likely clinical probability, V/Q scan and CTPA were done while if the clinical probability was a low/intermediate or unlikely, a D-dimer test was done. Based on the age-adjusted cutoff, the results of D-dimer test was deciphered: in patients < 50 years, PE was excluded if the D-dimer value less than 500μg/L. In patients ≥ 50 years, the D-dimer test result was considered negative if the value of D-dimer was less than their age multiplied by 10. Quantitative high sensitivity D-dimer assay was used: (Second-generation Tina-quant and Cobas h 232 Roche). Patients with a negative D-dimer test result did not undergo any further testing and no anticoagulant treatment was given. Patients with a positive D-dimer result underwent V/Q scan and CTPA. If PE was confirmed, patients started anticoagulant therapy while when PE was excluded, conventional angiography was done (to confirm absence of PE) and patients not given anticoagulant treatment.

3.2.Outcomes:-

In all patients with confirmed pulmonary embolism (14 patients), 30-day clinical follow-up data were acquired. During this 30 day, five patients had adverse clinical outcomes, including 2 who died within 30 days. Of the 3 surviving patients with adverse outcomes, 2 of them had secondary cardiogenic shock (defined by at least one of the following criteria: signs of end-organ hypoperfusion or systolic blood pressure <90 mm Hg, or a need for catecholamine administration to maintain systolic blood pressure > 90 mmHg, or objectively confirmed symptomatic recurrent venous thromboembolism) and one had renal impairment.

3.3.Multi-slice CT (MSCT):-

All patients were examined with 16-row multi–detector CT scanner (Mx8000; Philips Medical Systems, Cleveland, Ohio) with a pitch of 1.25, a collimation of 4 x 1 mm, 144 mAs and 120 kV. All data sets were reconstructed. Transverse images were reconstructed using a 180° linear-interpolation algorithm with a medium sharp filter with an interval of 0.6 mm and a matrix of 512 x 512 pixels.

A total of 100mL of low-osmolar contrast material, diluted with20–30 mL of saline was injected. at a rate of 4 mL/sec. The contrast material was administered with an automatic injector (Medrad, Pittsburgh, Pa) through a peripheral 18-gauge needle that was placed in an antecubital vein. The start delay time was decided based on to age and general condition. It ranged from 5 to 20 seconds. In patients < 60 years and free of heart failure, the delay was 5 seconds. While for older patients and patients with diminished cardiac function, the delay time was 20 seconds

We instructed the patients to hold their breath throughout study or to breathe as quietly as possible, if they could not hold their breath.

Craniocaudal imaging were done for all patients. The field of view was 430 mm. included the whole thorax, from the lung apex to the diaphragm.

Axial, coronal and sagittal images were routinely reconstructed at mediastinal (width, 400 HU; center, 0 HU) and lung (width,1500 HU; center, –500 HU) window settings.

3.4.Scintigraphy of the lungs:
Perfusion scintigraphy of the lungs was performed for all patients after intravenous administration of 150 MBq of technetium 99m (^{99m}Tc)–labeled macro aggregated albumin with the patient in the supine position. Images were acquired in four standard projections (posterior, anterior, left lateral and right lateral).
Ventilation scintigraphy with Tc-99m DTPA aerosol was performed immediately after each perfusion study. Using a face mask, the radioactive aerosol was administered at a rate of (1–3 L/min).

4.Image Interpretation:-

4.A. CT Interpretation:
The diagnosis of PE on MSCT was based on the presence of intraluminal hypodenity within the contrast enhanced arterial lumen. It then classified as either central (found in main or segmental branches) or might be peripheral (found in a peripheral subsegmental vessel). CT findings were considered negative for PE when there were good contrast opacification of the pulmonary arterial tree with no filling defects and preserved lung vasculature. If there were motion or breathing artefacts (that prevented assessment of any segmental artery) and also if enhancement of pulmonary arteries was non homogeneous or insufficient (as compared to that of pulmonary veins), the CT angiography was considered non-diagnostic.

4.B. Quantitative cardiovascular measurements:
Cardiac measurements including the right ventricle (RV) and left ventricle (LV) short axes. Axes were calculated as the biggest distance between the free wall of the ventricle and the inner side of the interventricular septum on one transverse image that is perpendicular to the long axis of the heart **(9-11)**. The RV/LV ratio was then ascertained from these estimations. Vascular measurements were also obtained for the diameters of ascending aorta , main PA lumen, superior vena cava and azygos vein. The ratio of the main PA to the aorta diameter was obtained. Vascular measurements were taken on multiplanar reformatted images in a plane perpendicular to the long axis of the vessel. The diameter of the main PA lumen was measured proximal to its branching division. Measurements of the aorta was done at the level of the middle third of ascending portion, of the part of the azygos vein facing the right tracheal wall, and for the superior vena cava at the level of the azygos arch**(12)**.

The effect of pulmonary embolism on the lung parenchyma including: the Mosaic attenuation due to pulmonary hypoperfusion; the cavitating or non-cavitating pulmonary infarctions; and the presence of pulmonary arterial hypertension complicating the chronic case. Mosaic oligemia is characterized by areas of reduced lung attenuation and reduced vessel diameter due to hypoperfusion and vasoconstriction. Normal unaffected regions are hyperattenuating as compared to the pathologic regions **(13,14)**. CT findings of pulmonary infarction are wedge shaped dense area with its base at the pleura and its apex towards the hilum**(13)**. The CT findings in chronic pulmonary arterial hypertension are central pulmonary artery dilatation, attenuated peripheral pulmonary arteries and right heart enlargement**(15)**.

4.C. V/Q Scintigraphy Interpretation:
A diagnosis of PE was excluded when no perfusion defects of any kind were seen on scintigraphic images. A diagnosis of PE was unlikely but not fully excluded (**low probability**) when there is perfusion defects with matched ventilation defects. A diagnosis of PE was made (**high probability**) when there is single or multiple, wedge-shaped perfusion defects, with a normal distribution of ventilation. A diagnosis of PE was likely but not certain **(intermediate probability**) when perfusion defects did not fulfill the criteria for the other categories.

The presence of PE was confirmed when there were concordant positive results of MSCT and a high-probability V/Q scintigram. In this situation, **pulmonary** angiography was not done and the patient was treated with anticoagulant therapy. When there were concordant negative results of MSCT and V/Q scintigram (a normal, low- or intermediate probability), the absence of PE was confirmed with conventional **pulmonary** angiography.
Patients whose MSCT and V/Q scans were discordant with clinical suspicion of PE also underwent **pulmonary** angiography.

4.D. Pulmonary Angiography:
Pulmonary angiography was done for 14 patients (12 patients with negative CT and perfusion scan and 2 patients with positive CT only with negative perfusion scan). Seldinger technique was used for catheterization via the common femoral vein. Non-ionic monomeric, low-osmolar contrast media were used. The volume of contrast

material were 40 ml at 2 s selectively in each pulmonary artery. A 7-F sheath was introduced and contrast was injected. Selective injections into the main right and left pulmonary artery were obtained unless PE was found in the first examined lung. The angiographic equipment used was both bi- and single-plane technique with cine angiography or digital subtraction angiography (DSA), 25 and 12.5 frames per second, respectively. At least two oblique projections of each lung were performed. The direct criteria of pulmonary embolism were, complete and abrupt cut off of a vessel usually with a concave border of the contrast column and an intra luminal filling defects in two views or more.

5. Statistical analysis:-

Data were statistically described in terms of frequencies (number of cases) and relative frequencies (percentages). Accuracy was represented using the terms sensitivity, specificity, +ve predictive value, - ve predictive value, overall accuracy.

Results were expressed as the mean ± standard deviation for data distributed normally. Imaging parameters were analyzed by ANOVA and chi-squared test. A ***P value*** < 0.05 was considered significant. All the data were analyzed using the Statistical Package for the Social Sciences (SPSS, version 15.0; SPSS, Inc., Chicago, IL, USA).

Results:-

This study included 25 patients, their ages range were 27 - 63 years (median, 44years), they were 7 males (age range 37- 49 & median, 43 years) and 18 females (age range 27 – 63 & median, 44 years). Pulmonary embolism was confirmed in 14 out of the 25 patients (56%) and excluded in 11 out of the 25 patients (44%) by imaging **(Table2).**

Pulmonary embolism was diagnosed by MSCT in 13 of 25 examined cases (with a relative frequency about 52%) **(Table 3).**

MSCT was able to diagnose central as well as peripheral pulmonary emboli. In 8 patients (61.54 %), the emboli were in central **pulmonary** arteries **[figure 1 and figure 2].** While in 5 patients, only segmental (3 patients 23.08%) or subsegmental (2 patients 15.38 %) branches **[figure 3]** were obstructed **(Table4).**

In 8 (66.67%) of the 12 patients negative for PE in MSCT, **MSCT** provided data that proposed other diagnosis. The other diagnoses including pneumonia (*n* = 3), pleural effusion (*n* = 2), small airways diseases (*n* = 2), and **pulmonary** fibrosis (n = 1) **(Table 5).**

Comparing the cardiovascular measurements between patients with adverse outcome and patients with no adverse outcome **(Table 6)** revealed a statistically significant differences in RV short axis (*P* value 0.022), RV/LV ratio (*P* value 0.011), aorta diameter (*P* value 0.040) and azygos vein diameter (*P* value < 0.001). While, there was no significant differences in LV short axis, PA diameter, PA/aorta ratio, and SVC diameter.

Pulmonary embolism was diagnosed by V-Q scan in 11 of the 25 examined cases (with a relative frequency about 44%) **(Table 3).**

High-probability V/Q scintigrams were obtained in 11 of 14 patients with PE. Normal or low-probability/Q scintigrams were obtained in 13 cases (of which 2 cases diagnosed as PE).One patient with intermediate-probability V/Q scintigrams had PE **(Table 7 and 8).**

There was one patient with false negative CT scan (**Table 9).** In this patient the technical quality of the CT examination was unsatisfactory because of poor opacification of the arteries and also due to severe tachypnea, however there was a high clinical suspicion of PE , so the patient underwent pulmonary angiography and PE was confirmed by pulmonary angiography **[figure 4].**

Pulmonary embolism was missed in 3 cases (3 false –negative) on V/Q scan. 2 of these cases (66.66%) the embolism were located in subsegmental arteries, while in one case (33.33%) embolism was in segmental arteries. None of the missed cases had pulmonary embolism in lobar arteries which means that the sensitivity of V/Q scan to detect pulmonary embolism is directly proportional to the caliber of the occluded vessel. There was one false-

negative but no false-positive MSCT results, while V/Q scan showed 3 false-negative and no false-positive results **(Table 9).**
In the present study; MSCT was found to have a higher sensitivity **(92.86 %)**, negative predictive value (**91.67 %)**and accuracy **(96 %)**in confirming and/or excluding PE than V/Q scan, while specificity and positive predictive value was 100% in both **(Table 10).**

The findings of V/Q scintigraphy and MSCT were compared in the 25 cases. concordant positive results were found in 11 cases and concordant negative results were found in 12. In 2 patients, the results of MSCT and V/Q scintigrams were discordant **(Table 11).**

Discussion:-

Pulmonary embolism is a wide spread cause of sudden death. Although PE can be lethal, it is manageable if it is diagnosed and treated in a proper time[16]. Hence, prompt diagnosis is essential and because the clinical manifestations and laboratory findings of pulmonary embolism are non-specific, the need for an accurate non-invasive screening imaging modality is highly in demand[2].

The MDCT has enhanced the assessment of peripheral pulmonary arteries, enabling high-resolution CT examinations of the whole thorax in a short breath-hold [2]**.** The small collimation as well as the high pitch in MDCT angiography improve the spatial resolution and fasten the examination; and so coverage from the aortic arch to the diaphragm can be done within few seconds with a resolution sufficiently high to visualize the pulmonary arterial tree clearly, involving the main, lobar, segmental and subsegmental branches [17]**.**

In our study, the relative frequency of PE diagnosed by MSCT angiography was 52% compared to a relative frequency of 44% diagnosed by V-Q scan. MSCT angiography was able to diagnose pulmonary emboli in our study group with a sensitivity of **92.86%**, a specificity of **100%,** positive predictive value of **100%,** negative predictive value of **91.67%,** and an accuracy of **96 %** compared to a sensitivity of **78.57%**, specificity of about 100%, positive predictive value of 100%, negative predictive value of **78.57%,** and 88% accuracy of V-Q scan.

In a study by Mayo, et al.[18] comparing Spiral CT angiography (SCTA) and V/Q scintigraphy in patients with suspected PE. SCTA had a sensitivity of 87% compared to 65% for V/Q scanning. These results were also in agreement with our study. The results of the present study were also in agreement with Qanadli et al.[19] who found that spiral CT angiography sensitivity was 90% and specificity 94%. So, they concluded that; spiral CT should be the primary modality for evaluation of patients with suspected PE.

Right ventricular dysfunction (RVD) is the most common cause of short-term mortality in patients with acute PE [10, 20].The pathophysiology of RVD in PE is thought to be due to a sharp increase in the right ventricular (RV) after-load caused by mechanical pulmonary arterial obstruction and pulmonary vasoconstriction [21]. Past s studies have reported that RV failure is a more precise indicator of the severity of PE than the degree of obstruction at angiography or scintigraphy[22].In the study of Lim et al. [23], they found that a RV diameter/LV diameter (RVD/LVD) ratio of greater than 1 measured on axial sections indicative of RV strain at pulmonary CT angiography, whereas others studies have proposed a threshold ranging 1–1.5 [24-26].

In our study, we used a threshold of 1.2, with a highly significant difference (P=0.011) between patients with adverse out come and patients with no adverse outcome. Our results were in agreement with those of van der Meer et al.[24], who reported a significantly higher RV/LV ratio in non survivors (mean=1.5) than in survivors (mean=1.1). Among vascular measurements in our study, the mean diameters of the azygos vein and aorta were higher in patients with adverse outcome than in patients with no adverse outcome. That was in agreement with the study of Ghaye et al.[12] who found that azygos vein, superior vena cava, and aorta diameters were significantly different ($P < 0.05$) between survivors and non survivors patients with PE.

Pistolesi et al, [27] reported upstream manifestations of right-sided heart insufficiency in systemic veins and showed significant correlations between right atrial pressure and superior vena cava and azygos vein diameters.

One of the advantages of MSCT is that it allows concomitant evaluation of the lung parenchyma and mediastinum and thus may provide an alternate diagnosis[28]**.**

In our study, alternative diagnosis was detected **by MSCT in** 8 (66.67 %) of the 12 patients that were negative for PE. The alternative diagnosis were pneumonia (n = 3), pleural effusion (n = 2), small airways diseases (n = 2), and **pulmonary** fibrosis (n = 1). This finding was keeping with the study done by Kim et al.[(29)],in which Spiral CT angiography established alternative diagnosis in more than 60% of patients. The spectrum included pneumonia, fibrosis, pleural abnormalities and cardiovascular disease.

The spatial resolution is significantly increased with MSCT thus enhancing the detection rate in the segmental and subsegmental vessels. In our study we have succeeded to diagnose emboli in segmental vessels with a relative frequency of 23.08 and in the subsegmental vessels with a relative frequency of 15.38. These results were comparable to that previously published [(13)].In our study, we found that none of the missed cases (3 cases) of PE in V/Q scan had pulmonary embolism in lobar arteries, PE was missed in 3 cases. In 2 of these cases the embolism were located in subsegmental arteries, and in one case the embolism was in segmental arteries, which means that the sensitivity of V/Q scan to detect pulmonary embolism is directly proportional to the caliber of the occluded vessel.

Goodman et al.[(30)] have suggested CT angiography as an essential screening methodology for PE , the authors concluded that CT pulmonary angiography could completely replace the V/Q scanning. However the abuse of CTPA in diagnosing PE is not cost-benefit as it presenting the patients to unnecessary radiation exposure and contrast induced nephropathy. It is possible to avoid unnecessary imaging requests by more adherences to PIOPED II investigators proposal. This could be accomplished with exact clinical risk evaluation by experienced clinicians. [(31)].

Figures:

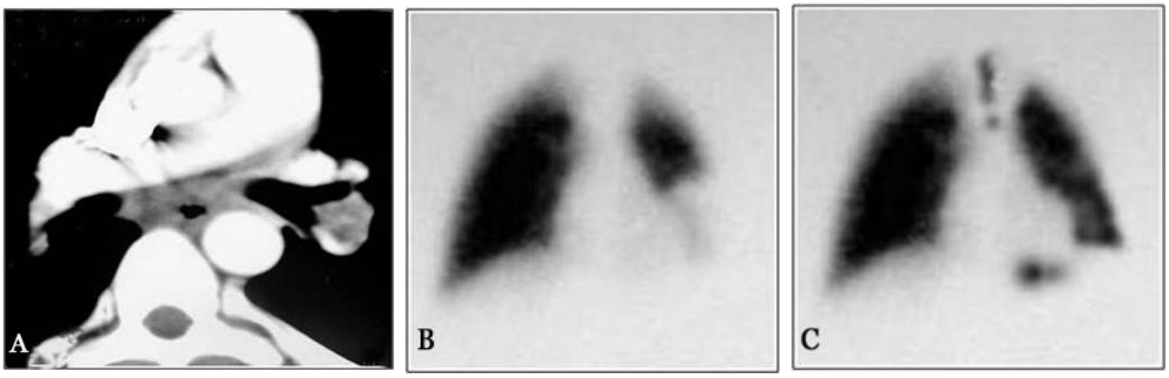

Figure (1): 33 years old female patient presented with cough, blood-tinged sputum and dyspnea.
(A) Multislice CT pulmonary angiography axial image revealed occlusion of the left lower pulmonary artery by embolus.
(B)& (C) Perfusion and ventilation scan anterior view showing large mismatched perfusion defect involving the left lower lobe (B) with no corresponding ventilation defect (c) denoting intermediate probability PE.

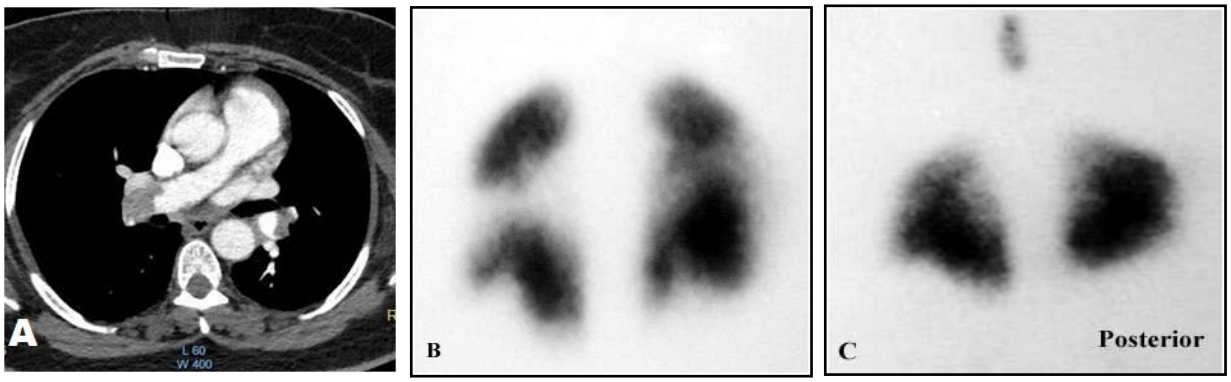

Figure (2): 40 years old male patient, smoker, presented by shortness of breath, chest pain and blood tinged sputum with previous history of DVT.
(A) Multislice CT pulmonary angiography axial image showing bilateral pulmonary artery embolism

(B) & (C) Perfusion - ventilation scan posterior views shows bilateral more than two large mismatched pleural based perfusion defects (B) with no corresponding ventilation defect (c) denoting intermediate probability PE.

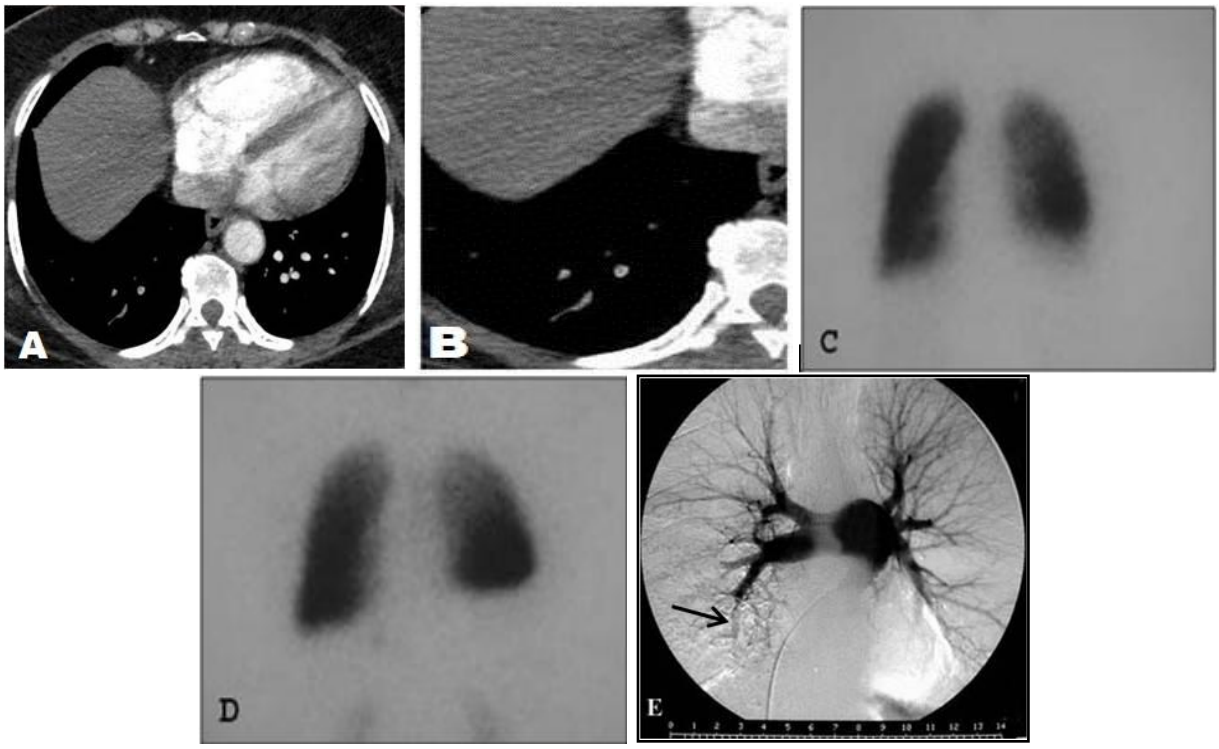

Figure (3): 49 years old male patient, heavy smoker, presented by cough, dyspnea and chest pain.
(A)&(B) Multislice CT angiography axial images revealed embolism in the posterior basal artery of the right lower lobe.
(C)&(D) Perfusion- ventilation scan posterior projections showed no perfusion defects.
(E) Pulmonary angiography was performed and confirmed the presence of the subsegmental embolism

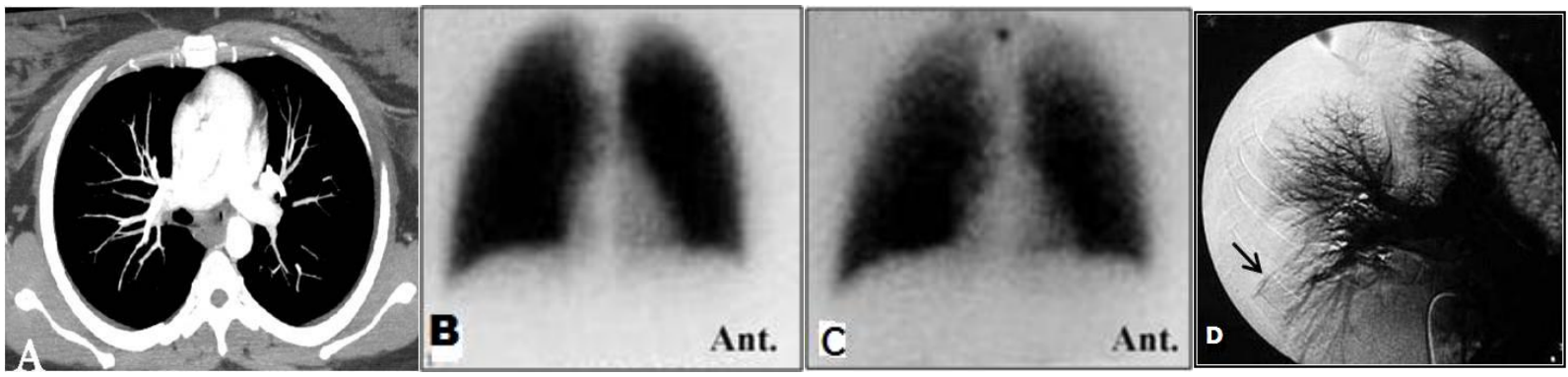

Figure (4): 51 years old female patient, presented by shortness of breath, and chest pain with previous history of DVT. On clinical examination; PE was highly suspected.
(A) Multislice CT axial image was reported as negative for PE.
(B) & (C) perfusion and ventilation scan (anterior view) shows no perfusion defect.
(D) Pulmonary angiography reveal a right lower pulmonary artery embolism.

Table 1. The Simplified, Revised Geneva Score and the 2-LevelWells Score	
Score	**Points**
Simplified, revised Geneva score [6]	
Age >65 y	1.0
Previous history of PE or DVT	1.0
Surgery or fracture within 1 month	1.0
Active malignancy	1.0
Unilateral leg pain	1.0
Hemoptysis	1.0
Heart rate, beats/min 75-94 ≥95	 1.0 2.0
Pain on lower-limb deep venous palpation and unilateral edema	1.0
Clinical probability Low Intermediate High	 0-1 2-4 ≥5
2-Level Wells score [8]	
Clinical signs and symptoms of DVT	3.0
Immobilization or surgery in the previous 4 week	1.5
Heart rate greater than 100 beats/min	1.5
Previous history of PE or DVT	1.5
Hemoptysis	1.0
Malignancy	1.0
Alternative diagnosis is less likely than PE	3.0
Clinical probability Unlikely Likely	 ≤4 >4
Abbreviations: DVT, deep vein thrombosis; PE, pulmonary embolism.	

Table (2): Frequencies and relative frequencies (percentages**) of final diagnosis in our cases.**		
Final diagnosis	**No of patients**	**Percentage%**
Positive PE	**14**	**56**
Negative PE	**11**	**44**
Total	**25**	**100**

Table(3): Frequencies and relative frequencies (percentages) of final diagnosis by MSCT and V-Q scan .				
Final diagnosis	**MSCT**		**V-Q Scan**	
	No of cases	**Percentage%**	**No of cases**	**Percentage%**
Positive PE	**13**	**52**	**11**	**44**
Negative PE	**12**	**48**	**14**	**56**
Total	**25**	**100**	**25**	**100**

Table (4): Frequencies and relative frequencies (percentages) of distribution of pulmonary embolism on MSCT angiography.		
Pulmonary embolism	**No of patients**	**Percentage (%)**
Central branch	8	61.54
Segmental branch	3	23.08
Subsegmental branch	2	15.38
Total	13	100

Table (5): Reported abnormalities in MSCT.		
CT Findings	**No. of Cases**	**Percentage (%)**
Pulmonary Embolism	13	52
Pneumonia	3	12
Small Air Way Disease	2	8
Pleural effusion	2	8
Pulmonary Fibrosis	1	4
Normal	4	16
Total	25	100

Table (6): Comparison between cardiovascular CT measurements in the 14 patients with confirmed PE.			
Cardiovascular measurement	**Adverse outcome (n= 5 patients)**	**No adverse outcome (n =9 patients)**	**P value**
RV short axis (in mm)	52.5 ±7.8	45.2 ±10	0.022*
LV short axis (in mm)	31.5 ±8.1	36.5 ±6.6	0.102
RV/LV ratio	1.7±0.6	1.2±0.4	0.011*
PA diameter (mm)	32.6±3.8	30.4±4.2	0.195
Aorta diameter (mm)	36.2±4.5	32.6±4.8	0.040*
PA/aorta ratio	0.9±0.1	0.9±01	0.298
SVC diameter (mm)	18.4±4.9	17.2±5.2	0.61
Azygos vein diameter (mm)	12.9±5.1	8.9 ±2.3	<0.001*
Data are presented by means ±SD. statistically significant <0.05			

Table (7): Results of V/Q scans on the studied population.		
V/Q Result	**No. of Cases**	**Percentage (%)**
High Probability	11	44
Intermediate	1	4
Low Probability	13	52
Total	25	100

Table (8): Comparison between the V/Q findings and the final diagnosis.			
V/Q Result	**No. of Cases**	**Diagnosed PE**	**Percentage (%)**
High Probability	11	11	100
Intermediate	1	1	100
Low Probability	13	2	15.38

Table (9): True positive, true negative, false positive and false negative cases in MSCT and V/Q studies.		
	CT	**V/Q**
True positive	**13**	**11**
True negative	**11**	**11**
False positive	**0**	**0**
False negative	**1**	**3**

Table(10): Comparison between V/Q and CT statistical data in our study.		
Statistical Parameter	**V-Q**	**CT**
Sensitivity	**78.57 %**	**92.86 %**
Specificity	**100 %**	**100 %**
PVP	**100 %**	**100 %**
PVN	**78.57 %**	**91.67 %**
Accuracy	**88 %**	**96 %**

Table (11): Comparison between V/Q and MSCT results.		
Comparative Result	**Number**	**Percentage (%)**
Concordant Positive	11	44
Concordant Negative	12	48
Discordant Results	2	8

Conclusion:-

MSCT is a rapid non-invasive diagnostic method. CTPA can be used as a primary screening and prognostic procedure for PE and could replace the V/Q scanning.

References:-

1. Anderson DR, Kahn SR, Rodger MA, et al. Computed tomography pulmonary angiography vs ventilation-perfusion lung scanning in patients with suspected pulmonary embolism. JAMA 2007;298 (23): 2743–53.
2. Schoepf UJ and Costello P**.** CT Angiography for Diagnosis of Pulmonary Embolism**:** State of the Art. Radiology 2004;230:329-337.
3. Ravenel JG, Northam MC, Nguyen SA: Negative predictive value of computed tomography pulmonary angiography with indirect computed tomography venography in intensive care unit patients. J Comput Assist Tomogr 2009; 33 (5):739-42.
4. Tambe J, Moifo B, Fongang E, et al. Acute pulmonary embolism in the era of multi-detector CT: a reality in sub-Saharan Africa. BMC Medical Imaging 2012; 12: 31. DOI 10.1186/1471-2342-12-31.
5. Le Gal G, Righini M, Roy P-M, et al. Prediction of pulmonary embolism in the emergency department: the revised Geneva score. Ann Intern Med. 2006; 144(3):165-171.
6. Klok FA, Mos IC, Nijkeuter M, et al. Simplification of the revised Geneva score for assessing clinical probability of pulmonary embolism. Arch Intern Med.2008;168(19):2131-2136.
7. Van Belle A, Buller HR, Huisman MV, et al. Christopher Study Investigators. Effectiveness of managing suspected pulmonary embolism using an algorithm combining clinical probability, D-dimer testing and computed tomography. JAMA. 2006; 295(2):172-179.
8. Wells PS, Anderson DR, Rodger M, et al. Derivation of a simple clinical model to categorize patients probability of pulmonary embolism: increasing the models utility with the SimpliRED D-dimer. ThrombHaemost. 2000;83(3):416-420.
9. Araoz PA, Gotway MB, Trowbridge RL, et al. Helical CT pulmonary angiography predictors of in-hospital morbidity and mortality in patients with acute pulmonary embolism. J Thorac Imaging 2003;18:207–216.
10. Van der Meer RW, Pattynama PM, van Strijen MJ, et al. Right ventricular dysfunction and pulmonary obstruction index at helical CT: prediction of clinical outcome during 3-month follow-up in patients with acute pulmonary embolism. Radiology 2005;235:798–803.
11. Quiroz R, Kucher N, Schoepf UJ, et al. Right ventricular enlargement on chest computed tomography: prognostic role in acute pulmonary embolism. Circulation 2004;109:2401–2404.
12. Ghaye B, Ghuysen A, Willems V, et al. Severe Pulmonary Embolism: Pulmonary Artery Clot Load Scores and Cardiovascular Parameters as Predictors of Mortality. Radiology 2006; 239(3): 884-891.
13. Engelke C, Prokop M. Pulmonary vascular computed tomography. In: Lanzer P, Topol EJ, eds. Panvascular medicine. 1st ed. Heidelberg, Germany: Springer-Verlag, 2002.
14. Tan RT, Kuzo R, Goodman LR, et al. Utility of CT scan evaluation for predicting pulmonary hypertension in patients with parenchymal lung disease: Medical College of Wisconsin Lung Transplant Group. Chest 1998; 113:12501256.
15. Ng CS, Wells AU, Padley SPG. A CT sign of chronic pulmonary arterial hypertension: the ratio of main pulmonary artery to aortic diameter. J Thorac Imaging 1999; 14:270278.
16. Mamlouk MD, van Sonnenberg E, Gosalia R, Drachman D, et al: Pulmonary Embolism at CT Angiography: Implications for appropriateness, Cost, and Radiation Exposure in 2003 Patients. Radiology 2010, 256:525–632.
17. Lawler LP. and Fishman EK. Multi-detector row CT of thoracic disease with emphasis on 3-D volume rendering and CT angiography. Radiographics 2001; 21:1257-73.
18. Mayo JR, Remy-Jardin M, Muller NL., et al. Pulmonary embolism: prospective comparison of spiral CT with ventilation-perfusion scintigraphy. Radiology 1997 205:447-52.
19. Qanadli SD, El Hajjam M, Mesurolle B, et al. Pulmonary embolism detection: Prospective evaluation of dual helical CT versus selective pulmonary arteriography in 157 patients. Radiology 2000; 217: 447-455.

20. Ribeiro A, Lindmaker P, Juhlin-Dannfelt A, et al. Echocardiography Doppler in pulmonary embolism: right ventricular dysfunction as a predictor of mortality rate. Am Heart J 1997;134:479–89.
21. Countance G, Cauderlier E, Ehtisham J, et al. The prognostic value of markers of right ventricular dysfunction in pulmonary embolism. Crit Care 2011;15:R 103.
22. Miller RL, Das S, Anandarangam T. Association between right ventricular function and perfusion abnormalities in hemodynamically stable patients with acute pulmonary embolism. Chest 1998;113:665–70.
23. Lim KE, Chan CY, Chu PH, Hsu YY, Hsu WC. Right ventricular dysfunction secondary to acute massive pulmonary embolism detected by helical computed tomography pulmonary angiography. Clin Imaging 2005;29:16–21.
24. Van der Meer RW, Pattynama PM, van Strijen MJ, et al. Right ventricular dysfunction and pulmonary obstruction index at helical CT: prediction of clinical outcome during 3-month follow-up in patients with acute pulmonary embolism. Radiology 2005;235: 798–803.
25. Araoz PA, Gotway MB, Harrington JR, Harmsen WS, et al. Pulmonary embolism: prognostic CT findings. Radiology 2007;242(3):889–97.
26. Collomb D, Paramelle PJ, Calaque O, et al. Severity assessment of acute pulmonary embolism: evaluation using helical CT. Eur Radiol 2003;13(7):1508–14.
27. Pistolesi M, Milne EN, Miniati M, Giuntini C. The vascular pedicle of the heart and the vena azygos. II. Acquired heart disease. Radiology 1984;152:9–17.
28. Lombard J, Bhatia R, Sala E. Spiral computed tomographic pulmonary angiography for investigating pulmonary embolism: clinical outcomes. Can Assoc Radiol J 2003 Jun; 54 (3): 147-51.
29. Kim K, Muller NL & Mayo JR: Clinically suspected pulmonary embolism: Utility of spiral CT . Radiology 1999; 210: 693-697.
30. Goodman LR, Curtin JJ, Mewissen MW, et al. Detection of pulmonary embolism in patients with unresolved clinical and scintigraphic diagnosis: helical CT versus angiography. *AJR Am J Roentgenol*. 1995 Jun. 164(6):1369-74.
31. Ghaye B, Dondelinger RF. When to perform CTA in patients suspected of PE? EurRadiol. 2008;18(3):500–9.