Computed Tomography Pulmonary Angiography Parameters in the Assessment of Acute Pulmonary Embolism with Short Term Prognosis

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ABSTRACT

Background: Pulmonary embolism (PE) is the third most common cause of cardiovascular death. When PE burden is severe, right ventricular failure usually occurs within the first few hours, so it should be diagnosed rapidly to identify patients who could benefit from fibrinolytic therapy.

Aim: Detection and assessment of CT pulmonary angiographic findings in patients with acute pulmonary embolism that can predict the short term sequel

Patients and methods: We assessed 30 patients investigated for PE and fulfilled the inclusion criteria by CT pulmonary angiography (CTPA)at CTA unit in Al-Najaf Center for Cardiac Surgery and Trans Catheter Therapy between January 2017-to September 2017. CTPAs were evaluated for PE clots burden on the basis of location and degree of obstruction ,right ventricular (RV) short axis ,left ventricular (LV) short axis ,RV/LV short axes ration .pulmonary artery (PA) diameter ,interventricular septal deviation and retrograde reflux of contrast to the IVC and then assess the correlation of these findings with the sequel of all patients after one month whether non survive or survive(cure or right ventricular failure) by doing complete .echocardiogramhy study to all survivals

Results: The mean age of the thirty patients enrolled in the study was47.2 + 14.6 (range: 30-78), females were relatively dominant represented 56.7
(n=17). Eleven (36.7%) patients had been completely cured while ***%***
patients end by having a degree of pulmonary hypertension (PHT) and 2(6.7%) were died. ***(%56.7)17***
Regarding the PE clots score, it is found that the score was high in those died (39.00 +1.4) and those with PHT (25.9+6.5) by comparison with cured patients (9.3+3.5). The thrombus.
Score had good predictor of bad sequel with a sensitivity of 89.5%. specificity 91%, accuracy of 90.2%, positive predictive value (PPV) of 90.8% and negative predictive value (NPV) of 89.7%. There were significant relationship between RV/LV ratio, bowing of IVS, PA diameter and retrograde flow of contrast into the IVC with those patients with PHTp<0.001.From other point of view, a significant direct (positive) correlation was found between thrombus score and each of RV/LV ratio, (R = 0.647, P< 0.001) and PA diameter (R 0.598, P< 0.001)

Conclusion
1.PE is a potentially life threatening disease with a challenging diagnosis..
2. CT pulmonary angiography (CTPA) is the diagnostic imaging of choice in the diagnostic approach for pulmonary embolism.
3.CTPA adds prognostic value by evaluating pulmonary clots burden, pulmonary artery diameter, IVS . bowing and IVC back-flow with simple RV/LV diameter ratio > 1.0 all can predicts risk for adverse outcome and give alarm for rapid and invasive management

Keywords: *CT, pulmonary embolism, PHT ,CTPA*

Overview

Pulmonary embolus (PE) defined as blockage of artery in the lungs by substance that has traveled from elsewhere in the body through the blood stream (1) and cause partial or complete occlusion of main pulmonary artery . or one of its branches

The incidence of PE about 1.5/1000 person/year(2)which remains high in spite of the advances in prophylaxes and diagnostic modalities
The mortality rate was about 8-15% in hemodynamically stable (3.4) but it canreachas high as 50% in those hemodynamically unstable.
The challenge was in rapid and very early diagnosis of PE as the death occur frequently with in the first few hours due to sever right heart failure and circulatory collapse(5,6)
In the past decade, computed tomography pulmonary angiography (CTPA) became the imaging modality of choice for proper, early, and accurate diagnosis of PE as it gives a total assessment clot burden in pulmonary circulations (7,8.9).
Pulmonary circulation anatomy (10)
The main pulmonary artery (MPA) pass in intrapericardial course posterosuperiorly from the pulmonary valve and then divides into right and left main pulmonary artery at level of fifth dorsal vertebra(D5) .The right pulmonary artery (RPA)is longer than the left pulmonary artery (LPA) this represent the main pulmonary artery (MPA)(11).
Both RPA and LPA are divided into lobar, segmental and subsegmental branches which pass parallel to their corresponding bronchi(12) The segmental arteries take their names according to the bronchopulmonary segment that supplied according to Jackson-Huber classification which is illustrated in table(2.1) . it should be know that this anatomy mapping is not fixed completely as the arteries to the posterior segment of left upper and those to the lingual segment having same course independent of corresponding bronchi. Also the right upper lobe segment can be supplied by accessory arteries from adjacent segment . then segmental and subsegmental arteries can arises as a common thank or as a separate arteries.

Table 2:1 Pulmonary Arteries Segments

Right lung		Left lung	
Superior lobe			
I	Apical segment	Apicoposterior segment	I
II	Posterior segment		II
III	Anterior segment	Anterior segment	III
Middle lobe		Lingula	
IV	Lateral segment	Superior lingular segment	IV
V	Medial segment	Inferior lingular segment	V
Inferior lobe			
VI	Superior segment		VI
VII	Medial basal segment		VII
VIII	Anterior basal segment		VIII
IX	Lateral basal segment		IX
X	Posterior basal segment		X

+

Pathophysiology of pulmonary embolism (13)
The pathophysiology and clinical manifestations of PE depend upon four main factors: a) the extent of occlusion of the vascular tree and the size of the emboli; b) the patient's pre existing cardiopulmonary condition . c) chemical vasoconstriction due to the release of serotonin and thromboxane from platelets that adhere to the embolus, as well as to fibropeptide B, which is a product of fibrinogenobreakdown; and d) the reflex vasoconstriction that is likely to occur as a consequence of pulmonary artery dilatation.(14) the pulmonary vascular resistance is low producing pressure on the right ventricle (RV)equal to quarter the value of pressure produced by the systemic circulation on the left ventricle (LV).
It is estimated that when the pulmonary circulation obstructed to a degree of 30% by emboli, then will be increase in the pulmonary circulation resistance and acute pulmonary hypertension result(15)
This pulmonary hypertension will be worsened by vasoactive agents released by plasma, platelet or tissues resulting to systemic arterial hypoxia
By using the Frank-starling mechanism , the RV can compensate the increase in pulmonary arterial circular resistance by increasing contractile performance but this mechanism need more oxygen demand to the myocardium , so the underlying cardiopulmonary status is an additional factor that influence on the acute pulmonary emboli impact
The RV dilatation, and bowing interventricular septum (IVS) toward to the LV resulting in a decrease of LV pre-load, so decreasing LV out put and decreased systemic arterial pressure loading to compromised coronary perfusion and ventricular ischemia which cause RV dysfunction and cardiogenic shock
4.1Types of pulmonary Embolism-
Anything can flow in the blood stream and can impact in the pulmonary arteries and it's branches can produce PE but the most common one is the blood clot(16)
Other example of emboli are fat from marrow of fractured bones . Tumor tissue or air bubble are another types also can produce emboli. Rarely, amniotic fluid emboli occur during delivery or immediately after the baby is born Hydrated cyst when located in RV and ruptured can produce pulmonary emboli
5.1:Diagnosis
Symptoms of PE(17)
Dyspnoca (especially if sudden and . unexplained)
Chest pain (especially if pleuritic) .
Non-productive cough Haemoptysis .
Syncope . Leg pain or swelling .
Signs of PE(18)
Tachypnoea (RR >16/min) ?
Tachycardia (HR >100bpm) .
Clinical signs of a DVT Hypoxia (SpO2 <95%) ?
Risk Factors for PE(19)
Recent major trauma (within 1 month)
Recent immobility (within 1 month) .
Recent surgery (within 1 month) .
Recent lower limb fracture (within 1 month)
Hypercoagulable states (e.g. Protein C or S deficiency, antiphospholipid syndrome)(19.20)
Active malignancy (or treatment within 6 months)
Pregnancy
80< .Exogenous oestrogen use Prior DVT/PE years of age(21) Obesity
Lab Investigation
Arterial blood gas analysis. A sudden drop in the blood oxygen level may suggest a pulmonary embolism.(22)
D dimer is a substance in the blood that is often increased in people with PE. D-dimer levels are abnormal in 95 percent of patients with PE(23)
ECG
ECG was performed in all patients as part of the clinical assessment before CT pulmonary angiography was performed . common findings in ECG are tachycardia, T wave inversion in leads V1-V4, S wave in V, and Q wave in V3 and inverted t wave in lead V3 (24)
Imaging
Plain film(25)
Chest x ray either normal, or may show plate atelectasis, Hampton hump (plural -based

opacity) triangular peripheral cone of infarct =blood in secondary pulmonary lobules, small plural effusion , Fleischner sign increase diameter of pulmonary artery (>16mm)and Westermark sign localized pulmonary oligemia.

CT angiography findings in PE

Qanadli et al.'s(20) scoring system was used to quantify the vascular obstruction using CTPA which is based on the obstruction of the pulmonary arterial segments developed secondary to PE. In brief, the Qanadli determines the number of blocked segmental arterial branches and then to be adjusted by a factor of one for partial blockage or a factor of two for completely obstructive PE. The maximum attainable score in this system is 40 (pulmonary trunk completely obstructed by thrombus), In this study, we used the same scoring system based on the site and degree of occlusion of pulmonary arteries

CT findings considered for the functional cardiovascular measurements include the ratio of RV to LV diameter (RV/LV ratio) , bowing of IVS and pulmonary artery diameter as signs of RV failure (27)

Reflux of contrast media consider as a sign of RV dysfunction Aviram et
28)@

MRI findings in PE

MR findings for acute PE were similar to those seen by CT or angiography, because all provided morphological representations of the same pathological process. An abrupt decrease in vessel diameter, and absence of contrast material in the vessel segment distal to the total obstruction, are definite signs of PE and are demonstrated in MR angiography (29,30) Other signs include a partial filling defect surrounded by contrast material, the "polo "mint.

Scintigraph

The ventilation-perfusion (V/Q) scintigraphiecan is clinically used for the diagnosis of pulmonary embolism (PE). In which it based on imaging the lung fields in ventilation phase and perfusion states and the presence of any mismatch between the two states images i.e whole lung , lobe , or segment that is ventilated well but not perfused suggest PE (31).

Aims of the Study

Detection and assessment of CT pulmonary angiographic findings in patients with acute pulmonary embolism that can predict the short term sequel.

Patients and Methods

Study design and setting 1-2

The sample was selected at the CTA unit in Al-Najaf Center for Cardiac Surgery and Trans Catheter Therapy, in Al-Najaf – Iraq. It was aprospective study conducted along nine months (between January and September 2017). There were 30 patients enrolled in this study.Patients whom diagnosed with pulmonary embolism included in this study.

Inclusion criteria

Patent with acute pulmonary embolism.

Exclusion criteria

LT sided heart failure .
Chronic lung disease Coronary artery disease
Pulmonic stenosis Tricuspid stenosis
Tricuspid regurgitation Pericardial constriction
Left-to-right shunt
Chronic pulmonary embolism
Patients lack follow up information
Patients with interstitial lung diseases.

2.2:Equipment and Methodology -

All CTPA examinations were acquired with a 64-slice scanner (Aquilion 64, V 4.51 ER 010, Toshiba Medical Systems, Tochigi, Japan) using 16?1.2 mm collimation, 110 kV, 300 mA, a pitch of 1.0, and 0.6 sec rotation. All transverse images were reconstructed with 1.5-mm slice thickness and 0.5-mm overlap with a matrix of 512x512 pixels. All CT images were acquired in a caudo-cranial direction from the level of the diaphragm to the lung apices in the mean duration of 5-10 sec for data acquisition. Patients received a total dose of 70-90 ml of 350 mg/ml Iohexol (Omnipaque 350mg 1/ml) according to the body weight of patients at a rate of 4 ml/s. A bolus tracking method was applied with the region of interest (ROI) in the pulmonary trunk. The trigger threshold was set at 120 HU and a start delay of 6 sec after reaching the trigger threshold was used.

Original reports had been based on the evaluation of thin axial images. Multiplanar reconstructions (MPR) and maximum intensity projections (MIP) were used at the discretion of the interpreting radiologist.

2.2.1:Pulmonary arteries clots score

Images were reviewed on an independent workstation (Vitrea System) by radiologists experienced in CTPA imaging (> 5 y of experience) at standard mediastinal windows (center, 50 H; level, 350 H).Radiologist observer was blinded to the patient's clinical data. The observer was free to review MPR and MIP and to change the window and level settings. The diagnostic criterion of embolism was the presence of endoluminal clots on CT scans. Central emboli included emboli within the main arteries, lobar arteries, or both. Peripheral emboli consisted of endoluminal clots within segmental and/or subsegmental branches. Radiologist was asked to score vascular obstruction. The percentage of Vascular obstruction was calculated according to the formula described by Qanadli et al, The arterial tree of each lung was assigned as 10 segmental arteries (three to the upper lobes, two to the middle lobe and to the lingula, and five to the lower lobes). The maximum CT obstruction index was (20 segmentsx2) Thrombus in segmental pulmonary artery received a score of 1 if partially occlusive, while 2 if completely occlusive. Thrombus in more proximal arteries received a score equal to the number of segmental arteries it supplied. As shown in figure (1) below, this represent thrombus causing complete occlusion of left lower lobe pulmonary artery.

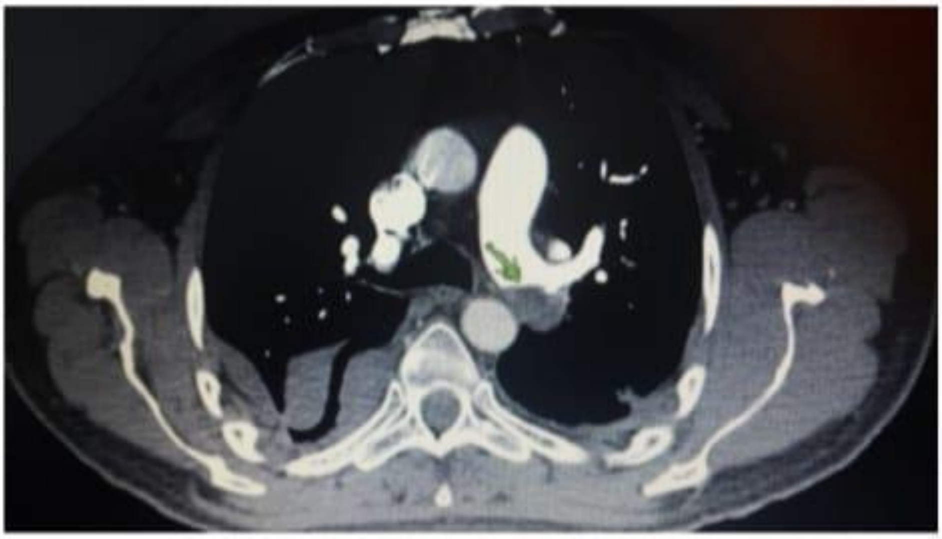

Fig 1. Thrombus causing complete occlusion at LT inferior main bronchus in 67- years old man

2.2.2:RV/LV short axes and ratio

Measurement of the short axes of the RV and LV on axial CT pulmonary angiograms. The short axis of the RV is measured at the level of the tricuspid valve from inner wall to inner wall at the widest point, which is typically in the basal third of the ventricle. The short axis of the LV is measured at the level of the mitral valve from inner wall to inner wall at the widest point, which also is typically in the basal third of the ventricle. It is important to know that the short axes of the RV and LV may be located at different axial CT levels

leftward bowing of the inter-ventricular
2.2.3:septum
Leftward bowing of the interventricular septum at CT has been related to sever PA obstruction. Increase RV pressure causing leftward bowing of interventricular septum as shown in figure below

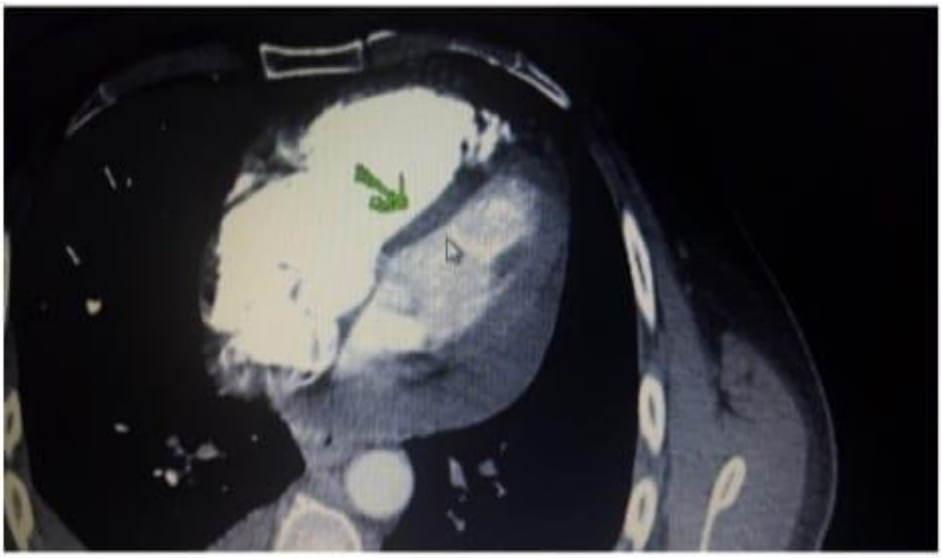

Fig 2 . .LT ward bowing of IVS with dilatation of RT ventricle in 50-years old women complain of PE

4.2.2:PA Diameter Measurement
Pulmonary artery axial diameter at level of its trunk was measured and the measurement should be up to 30mm,as more than 30mm indicate PA pressure greater than 20 mm/Hg

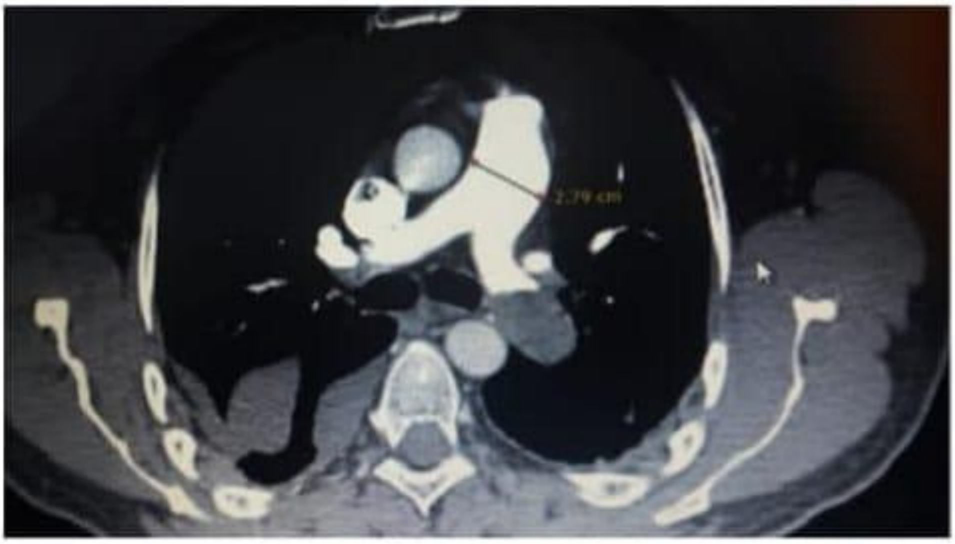

Fig 3. Pulmonary artery diameter in 40years old patient with acute PE

5.2.2:Reflux of Contrast Medium into IVC
Also we assess the presence of contrast enhancement in IVC and hepatic veins in all patients, which regarded as one parameter that indicate acute right heart failure

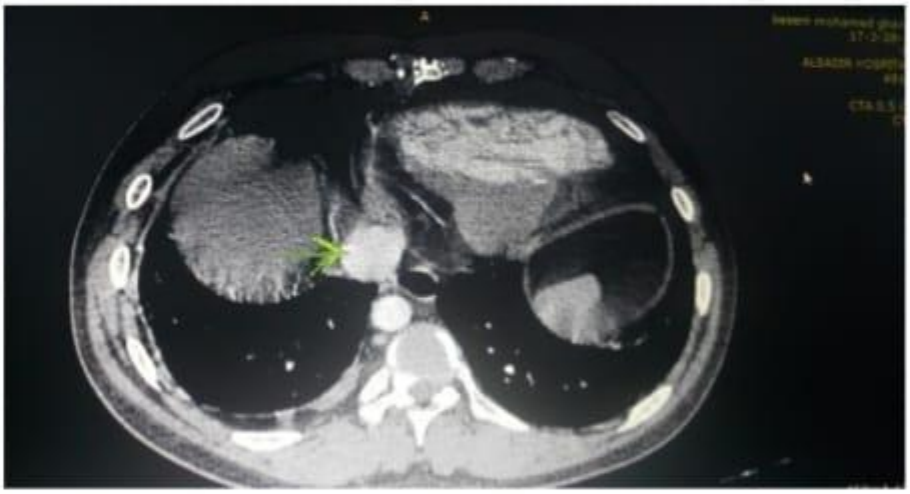

Fig 4. Reflux of contrast media to IVC in 67years old patient with acute PE

Follow up of the patients
After one month of treatment of patients with pulmonary embolism, patients followed up with echocardiogramhy by cardiologist , and different parameters were taken to asses RT ventricular function , first of all RT ventricular short axis & TAPSE(Tricuspid Annular Plain Systolic Excursion), which is linear M-Mode measurement of the RV longitudinal function , so . TAPSE value less than 17mm is highly suggestive of RT ventricle dysfunction (<17mm abnormal cutoff), also pulmonary artery diameter was measured.

Fig 5. Echocardiography Explain TAPSE in patient with pulmonary embolism

Fig 6. Echocardiography show longitudinal parasternal view for measuring PA diameter

Fig 7.Echocardiography explain measurement of RT ventricle in patient with pulmonary embolism , show dilated RT ventricle

Statistical analysis

Data of the studied group were analysed using the statistical package for social sciences, SPSS , version 24. Descriptive statistics presented as mean, standard deviation , frequencies and proportions . Student's t test was used to compare two means, while ANOVA test was used to compare the mean thrombus score across the sequele categories. Bivariate correlation test (Pearson's and Spearman's) were used to assess the correlation between thrombus score and other variables. Receiver operating characteristics (ROC) curve used to assess the validity of thrombus score in prediction of sequele. Level of significance was set at P value $ 0.05 to be significant.

Results

A total of 30 patients were enrolled in this study with a mean age of 47.2 + 14.6 (range: 30 – 78), on the other hand, 12 patients (40%) aged 30 – 39 years, 6 patients (20%) aged 40 – 49 years, 5 patients (16.7%) aged 50-59 years and 7 patients (23.3%) aged 2 60 years. Regarding the gender distribution, females were relatively dominant represented 56.7%. (Table3. 1)

The risk factors distribution revealed that among the 17 females, 11 (64.7%) were using contraceptive pills, and 6 (35.3%) had a history of cesarean section (C/S) The DVT was reported among 22 patients (73.3%) of the studied group , smokers were 12 (40%), hypertensive 11 (36.7%). Diabetic 10 (33.3%), surgery and trauma in 3 (10%), and other medical history in 4 patients ; Pancreatic tumor, Nephrotic syndrome, Cardiac disease (Table 3. 2) Figure 3. 1 demonstrates the Distribution of patients according to the Bowing IVS and Backflow of IVC where 13 patients (43.3%) had bowing IVS and 13 patients (43.3%) had backflow of IVC. As it shown in table 3, the mean RV/LV ratio of the patients was 1.0 + 0.3, and the mean PA diameter was 30.0 + 4 mm. The mean Thrombus score of the studied group was 20.7 + 10.8 (range: 4 – 40) Regarding the sequele of the patients, unfortunately, only 11 patients (36.7%) had been cured, while 17 patients (56.7%) had pulmonary hypertension (PHT) and 2 (6.7%) died, (Figure 3.2) Further analysis was performed to compare the mean thrombus score across the bowing IVS and backflow of IVC status, these comparisons revealed that patients with positive bowing IVS had significantly higher mean thrombus score compared to negative bowing IVS group, the mean thrombus score was 28.6 + 7.23 and 14.6 + 8.9, respectively, (P=0.001). Similarly, the patients with positive backflow of IVC had significantly. Higher thrombus score than negative backflow of IVC group, the mean thrombus score was 27.7 + 8.0 and 15.4 + 9.7, respectively, (P< 0.001), (Table3. 4 and figures3. 3&3. 4). From other point of view, a significant direct (positive) correlation was found between thrombus score and each of RV/LV ratio, (R = 0.647, P< 0.001) and PA diameter (R 0.598, P< 0.001), (Figures3. 5&3.6).

The comparison of mean thrombus score across the sequele categories using ANOVA test revealed that patients who were cured had the lower thrombus score, (9.3 + 3.5) compared to those with PHT, (25.9 + 6.5) and those who died, (39.0 + 1.4), (Figure3. 7) Furthermore, the receiver operating characteristics (ROC) curve analysis documented that thrombus score was good predictor of bad sequele of the patients, with a sensitivity of 89.5% , specificity 91% , accuracy of 90.2%, positive predictive value (PPV) of 90.8% and negative predictive value (NPV) of 89.7%, (Figure 3.8 and table3. 5). As it shown in(table3. 6) it had been significantly found that patient with +ve IVS were more likely to have PHT (12/13) with 92.3% , while among the 17 patients with -ve bowing IVS almost two third of them (64.7%) cured , p value =0.001, Furthermore similarly trend had been found regarding the relationship between +ve back flow and sequale p value < 0.05.

Regarding the correlation RV/LV ratio using ANOVA test revealed that patients with PHT and those who dead had significantly higher RV/LV ratio than those who cured , p value <0.05.By comparing PHT vs dead no significant difference in mean RV/LV ratio p value >0.05, (table 3.7).

On the other hand patents with PHT had significantly higher PA diameter (32.1mm) compared to cured (26.9mm) p value <0.001. No significant difference had been found neither between PHT and dead subgroups , nor cured vs dead PA diameter in both comparsion p value >0.05.

Table 3. 1. Age and gender distribution of the studied group (N = 30)

Variable		No.	%
Age (year)	30 – 39	12	40.0
	40 – 49	6	20.0
	50 – 59	5	16.7
	≥ 60	7	23.3
	Mean ± SD	47.2 ± 14.6	-
	Range	30 - 78	-
Gender	Male	13	43.3
	Female	17	56.7

SD: standard deviation

Table3. 2. Distribution of the risk factors among the studied group (N = 30)

Risk factor		No.	%
Oral contraceptive use (female n = 17)	Yes	11	64.7
	No	6	35.3
C/S		6	20.0
DVT		22	73.3
Smoking	Yes	12	40.0
	No	18	60.0
Hypertension		11	36.7
Diabetes		10	33.3
Surgery and trauma		3	10.0
Other medical history *		4	13.3

*Other medical history , Pancreatic tumor, Nephrotic syndrome, Cardiac hydatid cyst

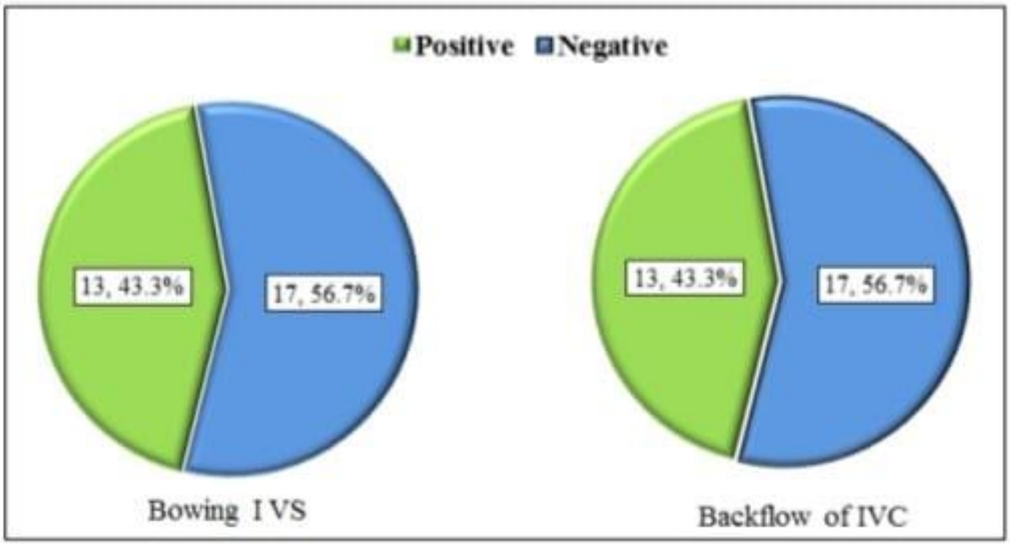

Figure3. 1. Distribution of patients according to the Bowing IVS and Backflow of IVC.

Table 3.3 Mean Values of RV/LV ratio and PA diameter of the studied group

Parameter	Mean	SD
RV/LV ratio	1.0	0.3
PA diameter (mm)	30.0	4.0
Thrombus score	20.7	10.8

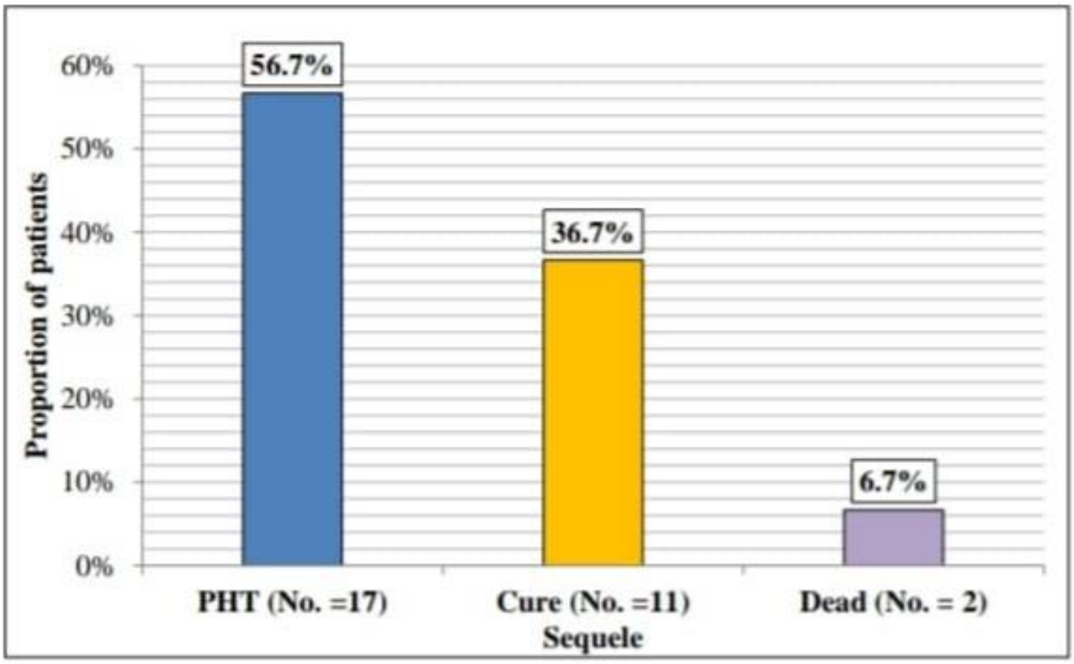

Figure3. 2. Sequele of the patients

Table3. 4. Comparison of thrombus score according to the Bowing IVS and Backflow of IVC

Parameter	group	No.	Thrombus score (Mean ± SD)	t test df.28	P. value
Bowing IVS	Positive	13	28.6 ± 7.3	4.72	< 0.001
	Negative	17	14.6 ± 8.9		
Backflow of IVC	Positive	13	27.6± 8.0	3.80	0.001
	Negative	17	15.4 ± 9.7		

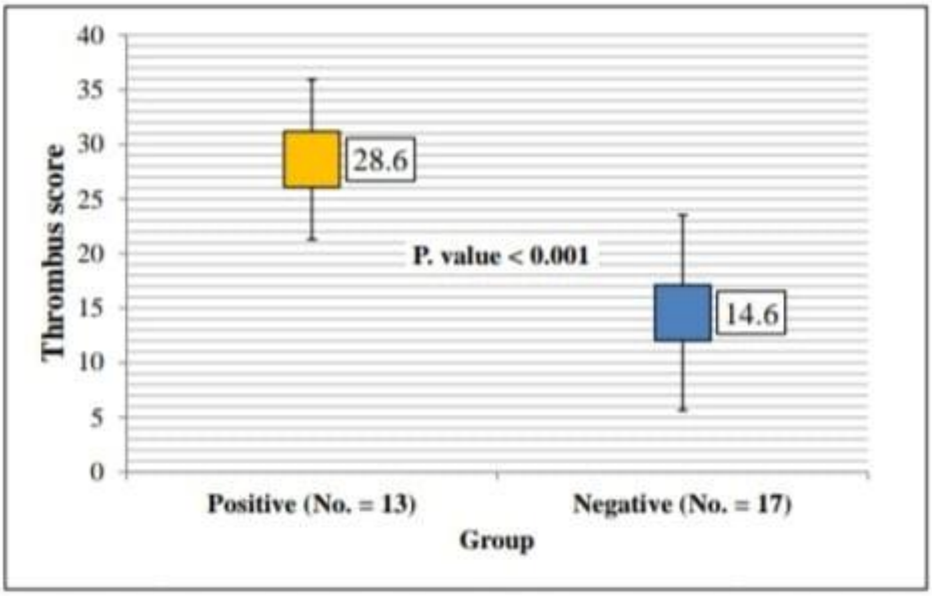

Figure3. 3. Comparison of mean thrombus score according to the Bowing IVS

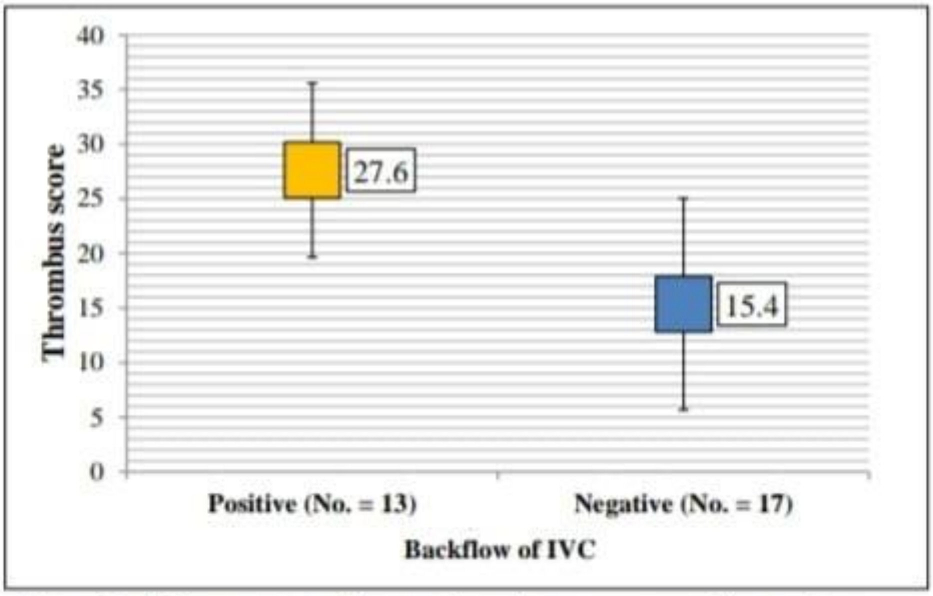

Figure3. 4. Comparison of mean thrombus score according to the Backflow of IVC

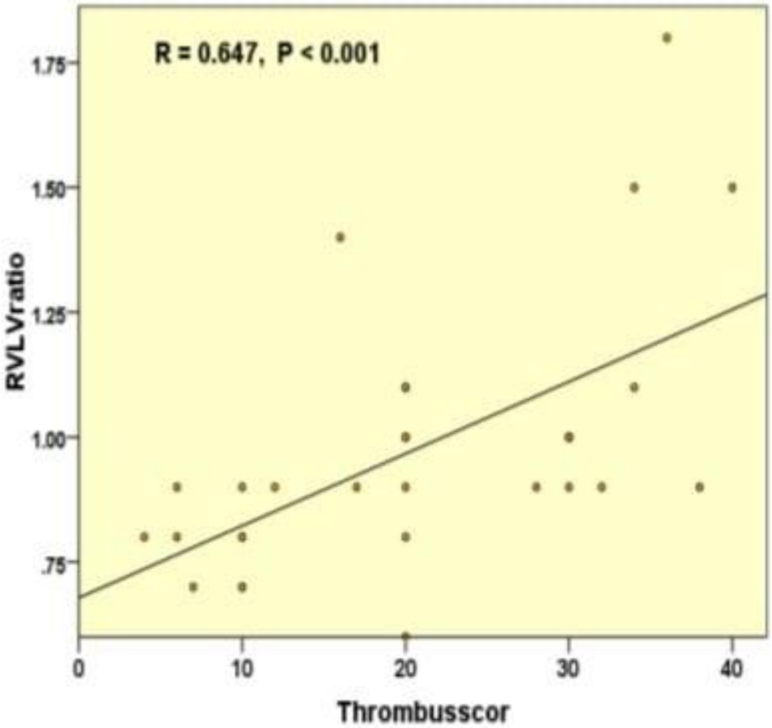

Figure 3. 5. Correlation between thrombus score and RV/LV ratio

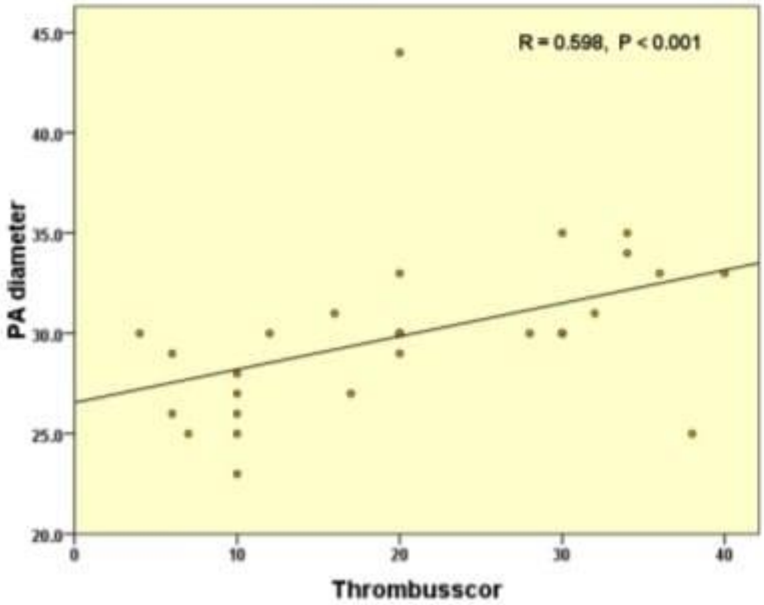

Figure3 6. Correlation between thrombus score and PA diameter

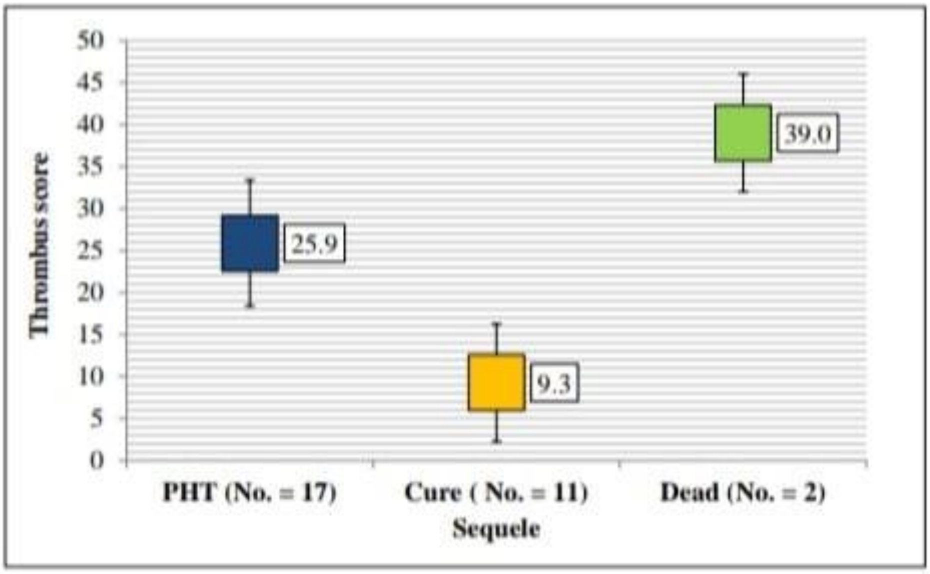

Figure3. 7. Comparison of mean thrombus score according to the sequele

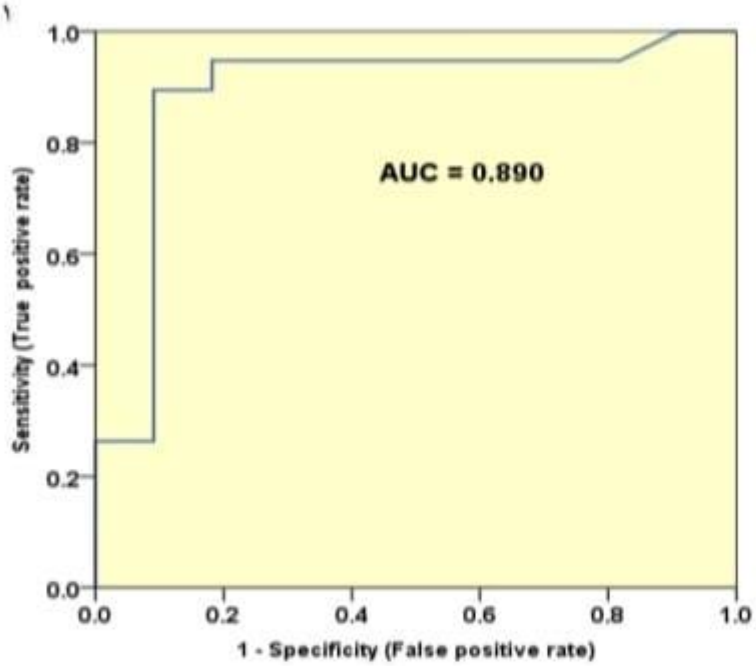

Figure3. 8. Receiver operating characteristics curve for the validity of thrombus score in prediction of sequele of the patient

Table3. 5. Validity parameters of thrombus score in prediction of sequele of the patients using the median score value (20) as cutoff point

Validity parameter	Rate
Sensitivity	89.5%
Specificity	91.%
Accuracy	90.2%
PPV	90.8%
NPV	89.7%

Table3. 6.Relationship of bowing VS and Backflow of IVC with sequele of the patients

		Sequele						P. value
		PHT		Cure		Dead		
		No.	%	No.	%	No.	%	
Bowing IVS	Positive	12	92.3%	0	0.0%	1	7.7%	0.001 sig
	Negative	5	29.4%	11	64.7%	1	5.9%	
Backflow of IVC	Positive	11	84.6%	1	7.7%	1	7.7%	0.015 sig
	Negative	6	35.3%	10	58.8%	1	5.9%	

Table 3. 7. Correlation between RV/LV ratio and sequele of the patients

sequele	No.	RV/LV ratio	
		Mean	SD
PHT	17	1.06	0.28
Cure	11	0.81	0.08
Dead	2	1.2	0.42
Total	30	1.0	0.27
ANOVA test, multiple comparison			
Overall		0.018	
PHT vs. Cure		0.011	
PHT vs. dead		0.43	
Cure vs. dead		0.041	

Table 3. 8. Correlation between PA diameter and sequele of the patients

sequele	No.	PA diameter	
		Mean	SD
PHT	17	32.1	3.6
Cure	11	26.9	2.2
Dead	2	29.0	5.7
Total	30	30.0	4.0
ANOVA test, multiple comparison			
Overall		0.002	
PHT vs. Cure		< 0.001	
PHT vs. dead		0.224	
Cure vs. dead		0.42	

Discussion

Acute pulmonary embolism (PE) is the third most common cardiovascular condition, after coronary artery disease and stroke (32) PE is a serious medical condition that could ultimately lead to death within few hours due to RV failure and circulatory collapse. Therefore, RV burden should be detected rapidly to identify patients who could benefit from early aggressive therapy. The noninvasive CTPA can safely and quickly identify the presence and extent of PE. CTPA is considered as the modality of choice for accurate diagnosis of PE(32.33) as it enables assessment of the pulmonary arteries emboli and detects associated underlying pulmonary disorders and other causes of acute chest pain (34)Moreover, it facilitates risk stratification of patients based on the degree of vascular obstruction (i.e ., clot burden)which could be used as a marker for appropriate selection of treatment.(35) Apart from the size of embolus, the clinical outcome of patients with PE also depends on various cardiopulmonary measurements (RV, LV, RV/LV ratio, PA diameter, backflow of contrast into IVC) identified by CTPA.A RV/LV diameter ratio cutoff value of >1.0 is commonly considered to represent RV dysfunction and has been shown to predict short-term adverse outcome and mortality (36.37,38) Many other secondary CT signs of RV dysfunction such as interventricular septum bowing, inferior vena cava reflux, and pulmonary artery diameter exceeding that of the aorta have been recognized, although without direct association with short- term mortality in acute PE(39).In this study ,the RV/LV ratio as well as the other secondary CT signs was assessed independently. A ratio >1 strongly suggests pulmonary hypertension, with 92% specificity and 96% PPV (40) Previous studies have reported that RV failure, resulting from both the volume of embolus and underlying cardiopulmonary function, is a more accurate indicator of the severity of PE than the degree of obstruction at angiography or scintigraphie two studies of 25 patients with PE and 14 patients with massive PE, Contractor et al (43) and Lim et al (44) found that RV/LV diameter ratio 2 1 and leftward septal bowing had a sensitivity of 78%-92%, specificity of 100%, and positive predictive value of 100% when compared to echocardiogramhic findings for the detection of RV dysfunction. Additional studies have estimated that RV/LV diameter ratio superior to 1.5 indicates a severe episode of PE (35,45). In the study by Araoz et al (21) a RV/LV diameter ratio greater than 1 was associated with a 3.6-fold increased risk of admission to the intensive care unit. More over ,Ghaye et al (34) recently demonstrated significant relation between the RV/LV diameter ratio and the risk of death in 82 patients who presented with a severe PE-related clinical condition that required admission to the intensive care unit An RV/LV diameter ratio greater than 0.9 calculated on a four-chamber view was associated with a sensitivity of 83% and specificity of 49% for predicting the occurrence of adverse clinical events (defined as 30-day mortality or the need for cardiopulmonary resuscitation mechanical ventilation, vasopressors, thrombolysis,or embolectomy) (34)

More recently, the same group of investigators reported a higher mortality rate in patients with an RV/LV diameter ratio greater than 0.9 compared to an RV/LV diameter ratio less than or equal to 0.9 calculated on a fourchamber view in 431 patients with PE.RV enlargement had a sensitivity, specificity, positive predictive and ,value, and negative predictive value of 92.3%, respectively, for prediction of 30-day %15.6 ,%38 ,%78.2 mortality (46)

In this study the RV/LV diameter ratio of 0.8 was cured , while RV/LV diameter ratio of 1had PH and ratio of 1.2 was dead.

Regarding the size of the main pulmonary artery at the level of pulmonary artery bifurcation, a variety of "upper limits" of normal diameter have been published (47,48). A PA diameter greater than 30 mm indicates a PA pressure greater than 20 mm Hg (49) Collomb et al (50) showed that the diameter of the main PA was significantly different between patients with severe PE and patients with non-severe PE. The diameter of the main

PA or the ratio of the diameters of the main PA and the aorta was not an indicator of mortality or severity of acute PE in three other studies (51,52) Qanadli et al (21)reported a poor correlation between the PA clot load scores and the mean PA pressure. In our study patents with PHT had significantly higher PA diameter (32.1mm) compared to cured (26.9mm) p value <0.001. No significant difference had been found neither between PHT and dead subgroups , nor cured vs dead PA diameter in both comparison p value >0.05.

Obstruction of more than 30% of the pulmonary circulation causes sufficient elevation of the pulmonary vascular resistance to produce significant pulmonary hypertension, resulting in RV after load increase and dilatation (4) Pulmonary angiography, and there was an excellent correlation between both scores and a good interobserver agreement in one study (55).The more recent scores proposed by Qanadli et al (21) and Mastora et al (54) were designed to quantitatively assess the severity of acute PE at CT pulmonary angiography. The present study quantified clot burden scoring according to Qanadii Score as it is more objective, easy to calculate, distinguish between

Partial and complete obstruction, and Has less interobserver variability Another upstream manifestation of acute right heart failure is the reflux of contrast medium into the IVC, which has recently been described as a predictor of mortality in patients with severe PE (55)

Reflux of contrast medium into the IVC is an indirect sign of tricuspid valve insufficiency, frequently observed in right heart failure

During severe acute PE, tricuspid regurgitation may develop as a result of RV dilatation, further reducing RV output . Nevertheless, Collomb et al (50) did not find a significant difference between patients with severe PE and patients with non-severe PE in regard to this sign In our study it had been significantly found that patient with +ve back flow of contrast to IVC were more likely to have PHT (11/13) with 84.6% , while among the 17 patients with -ve back flow (5.8.8%) cured , p value =0.015 . Furthermore similarly trend had been found regarding the relationship between +ve IVS bowing and sequale p value < 0.001 Further analysis was performed to compare the mean thrombus score across the bowing IVS and backflow of IVC status, these comparisons revealed that patients with positive bowing IVS had significantly higher mean thrombus score compared to negative bowing IVS group, the mean thrombus score was 28.6 + 7.23 and 14.6 + 8.9, respectively, similarly, the patients with positive backflow of IVC had significantly higher thrombus score than negative backflow of IVC group, the mean thrombus score was 27.7 + 8.0 and 15.4 + 9.7, respectively. From other point of view, a significant direct (positive) correlation was found between thrombus score and each of RV/LV ratio, and PA diameter The comparison of mean thrombus score across the sequele categories revealed that patients who were cured had the lower thrombus score, (9.3 + 3.5) compared to those with PHT, (25.9 + 6.5) and those who died, (39.0 + 1.4) and it documented that thrombus score was good predictor of bad sequele of the patients, with a sensitivity of 89.5%, specificity 91%, accuracy of 90.2%, positive predictive value (PPV) of 90.8% and negative predictive value (NPV) of 89.7% One of the limitations of the present study might be the inability to determine the specific cause of mortality in the patients who had PE. We have used the overall mortality data since the two patients who died in this study had multiple severe co-morbidities such as sepsis and end-stage malignancy but on the other hand the deaths occurred in the first week of the 30 days follow up increasing the assumption that the mortality was related to the event of acute PE. The retrospective nature of the study can be considered as a limitation. Yet, this might not be a real limitation because our study actually represents a snap shot of the "real life" situation in most medical centers.

Conclusion

1.PE is a potentially life threatening disease with a challenging diagnosis.

2. CT pulmonary angiography (CTPA) is the diagnostic imaging of choice in the diagnostic approach for pulmonary embolism.

3.CTPA adds prognostic value by evaluating . pulmonary clots burden, pulmonary artery diameter, IVS bowing and IVC back-flow with simple RV/LV diameter ratio > 1.0 all can predicts risk for adverse outcome and give alarm for rapid and invasive management.

RECOMMENDATIAN

Using thrombus score and other CTPA .
1..parameters as predictor for sequele of PE
Further studies to explore the link between . clinical presentation and biomarkers with
2.CTPA findings
Further studies with larger sample size and .
3.long term sequale are highly suggestive

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