Prognostic Value of Descending Aorta-to-Main Pulmonary Artery Density Ratio, Right-to-Left Ventricular Ratio and Pulmonary Artery Diameter in Acute Pulmonary Embolism

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ABSTRACT:

BACKGROUND:

Acute pulmonary embolism (PE) is an important, life threatening clinical issue and early diagnosis and treatment is essential to improve patient outcome and save life. Nowadays, computed tomography pulmonary angiogram (CTPA) represents the frontline investigation for detection of PE down to sub segmental pulmonary arteries.

OBJECTIVE:

To evaluate the role of descending aorta to main pulmonary artery (DA/MPA) density ratio as a predictor for the outcome of patients with acute PE using CTPA.

METHOD:

This is a prognostic prospective study conducted on 25 patients with mean age 45 years ± (range 17-73 years) in AL-Najaf center for cardiac surgery and trans-catheter therapy, AL-Najaf, Iraq. The DA/MPA density ratio, main pulmonary artery (PA) diameter and right ventricular: left ventricular (RV:LV) ratio were measured on axial sections on CTPA unit and then correlated with patients' outcome (hospitalization stay, complications and death) and then statistically assessed .

RESULTS:

Twenty five patients (sixteen females and nine males) with acute PE were included in this study. The acute PE is classified into massive (no = 15 patients) and sub massive (no = 10 patients) according to clinical state of patient (10) (30). There was weak correlation between DA/MPA density ratio and outcome of patients (p=0.2 and r=0.3) while PA diameter and RV:LV ratio showed stronger correlation (p=0.003 and r=0.6) and (p=0.01 and r=0.5) respectively. No death was reported.

CONCLUSION:

Compared to main PA diameter and RV:LV ratio, the DA/MPA density ratio is not so useful in predicting the outcome of patients with acute PE up to one month follow up. However further studies with longer follow up time are suggested.

KEYWORDS: Acute pulmonary embolism, computerized tomographic angiography, descending aorta, main pulmonary artery.

INTRODUCTION:

Acute pulmonary embolism (PE) is a sudden occlusion in the pulmonary artery (PA) [(1)]. It is a common and potentially fatal cardiovascular disorder [(2, 3)] and considered to be the third most common cause of death by acute cardiovascular disease after myocardial infarction and stroke when it goes undetected [(4)]. Imaging plays important role in diagnosis[(5)], with computed tomographic pulmonary angiogram (CTPA) is currently being the gold standard imaging technique for diagnosis and risk stratification[(6)]. PE carries variable prognosis and many prognostic factors have been suggested to predict acute PE outcome like right ventricular to left ventricular (RV:LV) ratio and main PA diameter [(7, 8, 9)]. Recently, few studies have suggested that measuring the descending aorta to main pulmonary artery (DA/MPA) density after intravenous enhancement on CTPA can predict PE-related major adverse events in patients with acute PE [(10, 11)]. This study was conducted to evaluate role of DA/MPA density ratio in predicting the outcome of patients with acute PE by using CTPA, compared with RV:LV ratio and main pulmonary artery diameter in.

PATIENTS AND METHODS:

Study design: This is a prospective prognostic study conducted on 25 patients (16 female and 9 male) at CT angiography unit of AL- Najaf

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Center for Cardiac Surgery and Trans-Catheter Therapy, along ten months period (February to December 2019).

Study population: Adult patients with proved (clinical, laboratory and CT angiographic) diagnosis of acute PE were included in the study, while patients any of the following was excluded: cardiac diseases; chronic PE; equivocal diagnosis (laboratory and imaging) and loss of follow up. Patients with acute PE were referred from cardiovascular and respiratory clinics presented with sudden onset dyspnea, chest pain, chest discomfort and/or syncope.

Equipment and CTPA examination**:** All examinations were performed by a 64-slice scanner (Aquilion 64, V 4.51 ER 010, Toshiba Medical systems, Tochigi, Japan, 2010) using following parameters: 16x1.2mm collimation, 135 kV, 600 mA, a pitch of 1.0 & 0.6 sec rotation.

Transverse images were reconstructed with 0.5mm slice thickness & 0.5mm overlap with a matrix of 512x512 pixels. 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 dose of 1ml/kg of 370 mg/ml Iopromide at a rate of 4 ml/sec. A bolus tracking method was applied with the region of interest in the pulmonary arteries. The trigger threshold was set at 180 HU and a start delay of 6 sec after reaching trigger threshold was used.

Radiological evaluation**:** PE was diagnosed by the presence of filling defect within main, lobar, segmental and/or sub segmental arteries. Images were reviewed on a workstation –Vitrea system by a board certified specialist radiologist experienced in CTPA imaging, who had the clinical data of cases. Density was measured within main PA and descending aorta in the same axial section at level of PA bifurcation using 1cm ellipse (figure 1-left) while PA diameter is measured at level of bifurcation (figure1-right). The heart was assessed for the presence of acute right ventricular (RV) strain by presence of RV dilatation with bowing or flattening of interventricular septum toward the left ventricle resulting in increased RV:LV ratio.

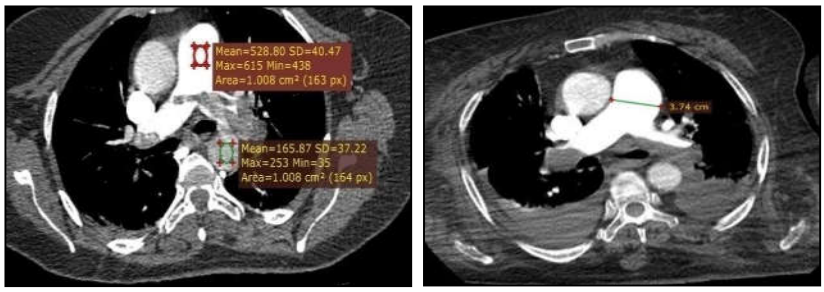

Figure 1: Axial sections of CTPA showing method of measurement of DA/MPA ratio (left) and PA diameter (right)

Patients were followed up for 30 days regarding the following information: hospitalization days; any complications like heart failure (HF) and pulmonary hypertension (PH), improvement or any reported death. Statistical analysis SPSS version 20 was used for analysis of data. Chi – square and fisher exact tests were used for comparison of categorical variables. Pearson correlation was used for the relationship between two continuous variables .ANOVA with LSD for mean comparison of three groups. P value equal or less than 0.05 was considered statistically significant.

RESULTS:

A total of 25 patients were included in this study with a mean age 45years ±14.9 and range of 17-73 years (table1), 16 females and 9 males with of 1.78:1 female: male ratio.

Table 1: Age distribution of studied sample.

Age group	No.	Percent
17 -35	8	32.0
36 -50	9	36.0
51- 73	8	32.0
Total	25	100.0

Regarding the fate of acute PE, most patients (20, 84%) were completely cured without complications, followed by 3 patients (12%) complicated by pulmonary hypertension and 2 patients (8%) complicated by heart failure (figure 2) while no death was reported (table 2).

Table 2: Sequels of studied sample.

Outcome	Frequency	Percent
No complication	20	84.0
Heart failure	2	4.0
Pulmonary hypertension	3	12.0
Total	25	100.0

Figure 2: A 61-year smoker, hypertensive and diabetic male. Axial image of CTPA showed bilateral PE, DA/MPA density ratio = 0.27%, hospitalized for 7 days and developed HF on follow up.

Hospitalization days (2-7 days), showed poor and statistically no significant correlation (r =0.3, p value=0.2) with DA/MPA density ratio (figure 3), fair and statistically significant correlation (r=0.5, p value =0.01) with RV:LV ratio (figure 4) and good and statistically significant correlation (r=0.6, p=0.003) with PA diameter (figure 5).

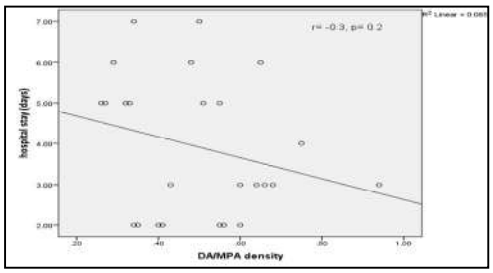

Figure 3: Correlation between hospitalization days and DA/MPA density ratio.

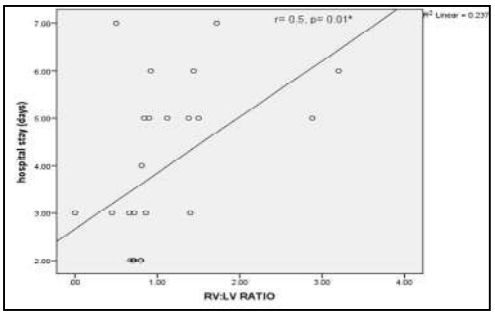

Figure 4: Correlation between hospitalization days and RV:LV ratio.

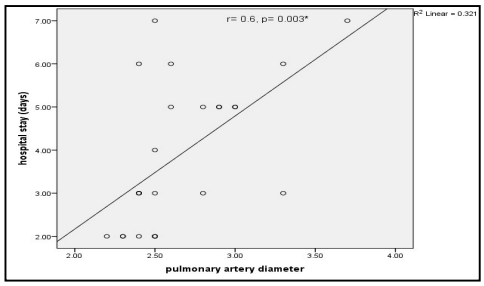

Figure 5: Correlation between hospitalization days and PA diameter.

Regarding complications, there was no statistically significant association with DA/MPA density (p=0.2) nor RV:LV ratio (p=0.3) but statistically significant association with PA diameter (p=0.0001) (table 3)

Table 3: Relationship of DA/MPA density, PA diameter and RV:LV ratio with complications.

		No.	Mean	Std. Deviation	95% Confidence Interval		P value
					Lower	Upper	
DA/MPA density	No	20	.507	.176	.425	.589	
	*HF	2	.305	.049	-.140-	.750	0.2
	**PH	3	.553	.110	.260	.827	
	Total	25	.496	.170	.430	.567	
Pulmonary artery diameter	No	20	2.550	.233	2.441	2.659	
	HF	2	2.700	.28	.157	5.241	0.0001
	PH	3	3.433	.231	2.860	4.007	
	Total	25	2.668	.3682	2.516	2.820	
RV:LV RATIO	No	20	.954	.627	.661	1.247	
	HF	2	1.690	1.683	-13.430-	16.810	0.3
	PH	3	1.347	.403	.346	2.347	
	Total	25	1.060	.704	.769	1.350	

DA/MPA descending aorta/mean pulmonary artery; RV: LV= right ventricular: Left ventricular; HF= heart failure; PH= pulmonary hypertension.

DISCUSSION:

CTPA represents an efficient mean for a highly accurate and cost effective diagnosis of acute PE [12, 6]. Predicting the fate of patient with acute PE at time of diagnosis will lead to an early management and better prognosis and make risk stratification simpler and rapidly available in an urgent setting [4, 13]. Studies have suggested RV strain at CT as prognostic parameter [3, 7, 14, 15]. Recently, few trails have assessed the DA/MPA density ratio as a possible predictive factor for the outcome in patients with acute PE depending on the fact that PE resulting in right ventricular (RV) strain leading to more contrast material being retained in PA so that the density will decrease in DA and increase in MPA[10, 11].Within 30 days follow up, there was no reported death, 20 patients were cured without complications, while 5 patients developed complications.

However, the lack of statistically significant difference in DA/MPA density ratio between those two groups, agreed with previous studies by Hefeda [3] and Javadrashid et al [11] that this ratio was not reliable indicator of prognosis in patient recently diagnosed with PE[3, 11], but disagreed with Park et al [10] who considered the DA/MPA density as predictor of death and severe complications. The mean age of patients in our study (45 years) was lesser than others [3 , 11] and may explain why death was not reported in our sample. RV failure is considered as the most common cause of early death among patients with acute PE and chest CT scan can determine the severity of RV dysfunction[16]. Our result regarding increased RV:LV ratio, agreed with previous reports that this ratio was predictive for adverse outcome, increase hospitalization period and 30 days poor

prognosis[16, 8]. PA diameter is associated with short-term adverse outcomes in patients with acute PE[8] and this explains the correlation between increased PA diameter with more hospitalization days in our study supports.

CONCLUSION:

DA/MPA density ratio, was not associated with outcomes of acute PE and less reliable than RV:LV ratio and PA diameter as prognostic factor. On other hand, RV:LV ratio showed strong correlation with hospitalization days while PA diameter showed stronger correlation with both hospitalization days and complications. The study recommends more future studies with larger sample size and longer period of follow to assess its clinical value.

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