Research Article

Assessment of right ventricular dysfunction in acute pulmonary thromboembolism by using various scoring system

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Abstract

Introduction: Pulmonary embolism is a serious and potentially fatal condition which is associated with significant morbidity and mortality. Diagnosis of pulmonary embolism continues to pose a challenge to both clinicians and radiologists because the clinical signs and symptoms of PE are non-specific. Mortality rate observed in pulmonary embolism is 2–7%, even when treated with anticoagulation. **Aims and Objectives:** To study and compare the various computed tomographic pulmonary thromboembolism scoring systems in predicting the right ventricular dysfunction in acute pulmonary thromboembolism. **Materials and Methods:** In the present study all patients who were diagnosed to have acute pulmonary embolism and confirmed by CT Pulmonary Angiogram. Patients who have previously been diagnosed and treated with pulmonary embolism in the past were excluded. Total 103 cases of acute pulmonary embolism were diagnosed in the present study during the study duration. Out of them 50 patients had RV dysfunction and 53 patients did not have RVD. All the patients included in the study were scanned on a 64-slice GE light speed VCT and 16-slice PHILIPS BRILLIANCE CT machines. Three pulmonary artery obstruction indices were calculated for each patient viz Miller, Walsh and Quanadli scoring systems. **Results:** Out of total 103 patients in the present study, 50 of them had RVD and 53 were not having RVD. According to Miller's scoring system the mean score in RVD group was 11.92±4.38 whereas in non RVD group was 9.13±3.61 and the difference observed statistically significant. According to Welsh and Qanadli scoring system also the difference in RVD and non RVD group was statistically significant. The mean Pa diameter in RVD group was 28.38±4.29 whereas in non RVD group was 26.87±2.55 and the difference observed was statistically significant. RV/LV Ratio in RVD group was 1.144±0.23 and in non RVD group was 0.79±0.11 and the difference observed was also statistically significant. IVS bowing was observed in 13 cases in RVD group and one case in non RVD group. **Conclusion:** Thus the present study showed that the three angiogram based scoring system (Miller, Walsh and Qanadli) were able to accurately identify patients with RVD in acute pulmonary thromboembolism. Of these three scoring system the Qanadli score was the better predictor of RVD and it was the more reliable and easily reproducible scoring system.

Keywords: Right ventricular dysfunction, acute pulmonary thromboembolism, Miller, Walsh and Qanadli scoring system.

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INTRODUCTION

Pulmonary embolism is a serious and potentially fatal condition which is associated with significant morbidity and mortality. It is the third most-common cause of cardiovascular death after myocardial ischemia and stroke[1]. Diagnosis of pulmonary embolism continues to pose a challenge to both clinicians and radiologists because the clinical signs and symptoms of PE are non-specific. Mortality rate observed in pulmonary embolism is 2–7%, even when treated with anticoagulation.[2] In

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recent years various laboratory tests such as D-dimer have played an increasing role in the accurate diagnosis of patients with suspected pulmonary embolism, but for most practical purposes computed tomography has practically become the first-line imaging test in daily clinical routine. The most important advantage of CT over other imaging modalities is that both madiastinal and parenchymal structures can be evaluated, and thrombus can be directly visualized. CT may not only be used for evaluating thoracic anatomy in cases where PE is suspected, but also allows the derivation of physiologic parameters on lung perfusion at single-detector row electron-beam and multi-detector row CT. It is also now possible to scan the entire chest faster at the peak of contrast material opacification during a single breath-hold[3]. Echocardiography is recommended as the first-line exam in patients in cases of pulmonary thromboembolism to detect signs of right ventricular dysfunction (RVD). The introduction of multidetector computed tomography (MDCT) pulmonary angiography has considerably changed the approach to PE and is currently the diagnostic method of choice. Since MDCT is the first-line technique to diagnose PE, assessing RVD by this technique would facilitate risk stratification in all patients.[4] Small studies using helical CT have suggested that the ratio between right ventricular (RV) and left ventricular (LV) short-axis diameters is an accurate sign of RVD.[5,6,7,8] Besides direct and indirect signs of RV overload, the severity of PE as quantified by scoring systems has been proposed as an important predictor of RVD.[7,8,9,10] Typically, an obstruction index of 40–60% is associated with intermediate/high-risk PE. The magnitude of pulmonary embolism can be calculated at CT pulmonary angiography by applying angiographic scores adapted for CT (Miller and Walsh scores) or dedicated CT scores (Quanadli and Mastora scores). In the present study we tried to study RV dysfunction using score system postulated by Miller, Walsh and Quanadli.

AIMS AND OBJECTIVES

To study and compare the various computed tomographic pulmonary thromboembolism scoring systems in predicting the right ventricular dysfunction in acute pulmonary thromboembolism.

MATERIALS AND METHODS

The present study was conducted in the department of radiology of Sri Ramachandra University from May 2011 to September 2013 among the patients of acute pulmonary embolism. All patients who were diagnosed to have acute pulmonary embolism and confirmed by CT Pulmonary Angiogram. Patients who have previously been diagnosed and treated with pulmonary embolism in the past were excluded. Thus total 103 cases of acute pulmonary embolism were diagnosed in the present study during the study duration. All the study subjects were then divided in two groups.

- **Group A:** patients with right ventricular dysfunction
- **Group B:** patients without right ventricular dysfunction

All the study patients were subjected to CT scan. Patients included in the study were scanned on a 64-slice GE light speed VCT and 16-slice PHILIPS BRILLIANCE CT machines. Scout images are obtained (kV – 120 and mA - 10) from the lung apices to the lowest level of hemidiaphragm in a supine position during suspended inspiration or shallow breathing, depending on the patient's level of dyspnea. The field of view was appropriately adjusted to the size of the patient. The region of interested (ROI) is then set at the right atrium. The contrast is injected through the 22G venflon present in the right cubital vein at the rate of 175 PSI (Pascal square inch) through Mallinckrodt dual head pressure injector. A total volume of contrast is given according to the patient's body weight, therefore about 1.2ml/kg body weight is the criteria for the volume of contrast to be injected. The total kV – 120 and mA – 724 was standard exposure values during the contrast phases and the mA would be adjusted automatically according to the patient's body surface area. Two phases are acquired PHASE I – from the lowest level of the diaphragm to the lung apices and PHASE II – from the lung apices to the lowest level of the diaphragm. CT data were transferred electronically to ADW 4.4 GE workstation. Post processing thrombi, as assessed by PTCA, were localized in the common pulmonary, lobar, and segmental arteries. Three pulmonary artery obstruction indices were calculated for each patient. The scoring systems compared were summarized in below table.

Pulmonary clot scoring system

Scoring system	Arteries scored	Weighting	Maximum score
Qanadli *et al*[12]	10 segmental arteries for each lung(total 20)	0 = normal 1 = partial 2 = total	40
Miller *et al*[13]	Right PA 9 segmental branches	Upper lobe = 3 Middle lobe = 2 Lower lobe = 4	16
	Left has 7 segmental branches	Upper lobe = 2 Middle lobe = 2 Lower lobe = 3	
Walsh *et al*[14]	Abnormalities in a single segmental PA receives a total score of 1,	**Right PA** Upper lobe = 3 Middle lobe = 2 Lingular lobe = 0 Lower lobe = 4 **Left PA** Upper lobe = 3 Middle lobe = 0 Lingular lobe = 2 Lower lobe = 4	18

The collected data was entered in the proforma and was analyzed by using appropriate statistical tests and presented with appropriate tables and graphs.

RESULTS

Table 1: Age and sex wise distribution

		Group A (right ventricular dysfunction)	Group B (no right ventricular dysfunction)	P value
Age group	21-35	12 (24%)	16 (30.19%)	0.688
	36-50	15 (30%)	16 (30.19%)	
	51-65	13 (26%)	15 (28.30%)	
	66-80	9 (18%)	6 (11.32%)	
	>80	1 (2%)	0 (0.00%)	
Sex	Male	31 (62%)	33 (62.26%)	0.978
	Female	19 (38%)	20 (37.74%)	

It was observed that majority of the patients in both the groups were less than 50 years of age. The proportion of male patients in group A was 62% while in group B was 62.26%. The age and sex wise difference in both the groups was statistically not significant.

Table 2: Distribution of cases according to mean score in scoring system

Scoring system	RV dysfunction	NO RV dysfunction	p value
MILLER	11.92 ±4.38	9.13 ±3.61	0.000657112
WELSH	13.12 ±3.62	10.34 ±3.22	0.0000809031
QANADLI	24.78 ±4.98	19.34 ±4.39	0.000000056

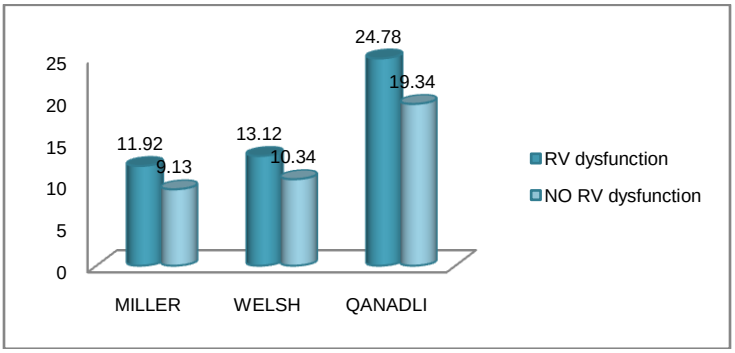

Figure 1: Distribution of cases according to mean score in scoring system

According to Miller's scoring system the mean score in RVD group was 11.92 ±4.38 whereas in non RVD group was 9.13 ±3.61 and the difference observed statistically significant. According to Welsh and Qanadli scoring system also the difference in RVD and non RVD group was statistically significant.

Table 3: Distribution of patients according to Pa diameter, RV/LV Ratio and IVS bowing

	RV dysfunction	NO RV dysfunction	p value
Pa Diameter	28.38 ±4.29	26.87 ±2.55	0.03103
RV/LV Ratio	1.144 ±0.23	0.79 ±0.11	<0.00001
IVS bowing present	13	1	0.0003584

The mean Pa diameter in RVD group was 28.38 ±4.29 whereas in non RVD group was 26.87 ±2.55 and the difference observed was statistically significant. RV/LV Ratio in RVD group was 1.144 ±0.23 and in non RVD group was 0.79 ±0.11 and the difference observed was also statistically significant. IVS bowing was observed in 13 cases in RVD group and one case in non RVD group.

DISCUSSION

The present study was conducted to study the right ventricular dysfunction in acute pulmonary thromboembolism. Various pulmonary angiographic scoring systems have been postulated to assess the severity of the thrombus load in the pulmonary arteries. In the study the severity of the thrombus load was evaluated using three scoring systems which were Miller, Walsh and Quanadli scoring systems. Along with these scoring systems, the other parameters including PA diameter, RV/LV ratio, IVS bowing and the reflux into the IVC and the hepatic veins were estimated. The values obtained from these three scoring systems are compared with ECHO findings in predicting right ventricular dysfunction. Total 103 patients were diagnosed with acute pulmonary embolism by CT Pulmonary Angiogram. The patients who had RV dysfunction among these 103 patients were obtained by their respective ECHO findings. Out of them 50 patients had RV dysfunction and 53 patients did not have RVD. It was seen that majority of the patients in both the groups were less than 50 years of age. The proportion of male patients in group A was 62% while in group B was 62.26%. The age and sex wise difference in both the groups was statistically not significant. Thus both the groups were comparable with respect to age and sex. The right PA has 9 major segmental branches (3 to the upper lobe, 2 to the middle lobe, and 4 to the lower lobe), and the left PA has 7 major branches (2 to the upper lobe, 2 to the lingula, and 3 to the lower lobe). In Miller score the presence of the filling defect or obstruction in any one of these branches scores 1 point. A filling defect proximal to segmental branches scores a value equal to the number of segmental branches arising distally. The maximum score is therefore 9 for the right lung and 7 for the left lung, with the maximum possible CT obstruction score of 16 for both lungs[12]. The mean score in RV dysfunction group was 11.92 ±4.38 whereas in no RV dysfunction 9.13±3.61 and the difference observed in both the groups was also statistically significant. Walsh Score has a maximum of 18 for both lungs. The following guidelines apply to embolic abnormalities: (a) filling defects in a single segmental PA receive a total score that does not exceed 1, regardless of the type or number abnormalities; (b) the total maximum score is 3 for abnormalities in a single upper lobar region, 2 for abnormalities in the middle lobe or lingula, and 4 for abnormalities in the lower lobes; (c) obstructions in central anatomic regions receive scores according to the vessel involved; (d) if the total score for one lung is greater than 4 without considering filling defects in central regions, the central filling defects are ignored. All filling defects in a single central region, whether single or multiple, receive a score of 3; (e) if a single vessel contains both a filling defect and obstruction, only the obstruction is scored; (f) the sum of scores for all abnormalities in one lung may not exceed a value of 9, and the maximum CT obstruction score is 18.[14] The mean value for the Welsh score in patients with RVD was 13.12 ±3.62 and in non RVD group was 10.34 ±3.22 and the difference in the mean value was statistically significant. Bankier *et al*[15] have used two angiographic indexes, the Walsh score and the Miller index, to quantify the severity of embolic pulmonary artery obstruction on helical CT. The more commonly used of these two scores in helical CT is the Miller index, because it is relatively simple to extrapolate to CT requirements. The arterial tree of each lung is regarded as having 10 segmental PAs (3 to the upper lobes, 2 to the middle lobe or lingula, and 5 to the lower lobes). Similar to the Walsh score, in Qanadli Score system the embolism of a segmental PA is scored as 1 point, and emboli at the more proximal arterial level are scored at a value equal to the number of segmental PAs arising distally. To provide additional information on the residual perfusion distal to the embolus, a weighting factor is used for each value (0 = no defect, 1 = partial occlusion, and 2 = complete occlusion). An isolated subsegmental embolus is considered as a partially

occluded segmental PA and is given a value of 1.The maximum CT obstruction index is 40.[12] The mean value for the Qanadli score in patients with RVD was 24.78 ±4.98 and mean value for the patients without RVD was 19.34 ±4.39 and the difference in the mean value was statistically significant. In our study 50 patients who had right ventricular dysfunction also had RV/LV ratio >1.0 which was statistically significant (p =0.0001). Additional studies have also estimated that the RV/LV diameter ratio >1.5 indicates a severe episode of PE[16,17,18,19,20]. According to Araoz *et al*[21], an RV/LV diameter ratio >1 was associated with 3.6 fold-increased risk of admission to the ICU. Moreover Ghaye *et al*[19] recently demonstrated a 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 in the ICU. In present study, the mean value for the pulmonary artery diameter in patients who had RVD was 28.38 (p *<0.05*) was statistically significant and the mean value for patients without RVD was found to be 26.87 which showed that the diameter of the main PA was significantly different between patients with severe PE and patients with non-severe PE which strongly correlates with the Collomb *et al* study[17]. In the present study IVS bowing was present in about 13 patients who had right ventricular dysfunction and 1 patient had IVS bowing without RVD. The rest of the patients were negative for IVS bowing. Collomb *et al*[17], Araoz *et al*[21] found that this sign as an indicator of the severity of PE or of subsequent admission to the intensive care unit (ICU). However this sign does not seem to be an indicator of outcome[18,19,21] and it is not specific for PE, as it can be found in numerous causes of chronic pulmonary artery hypertension[17], which correlates our study. In comparison of all three scoring systems used, all three adequately identify RV dysfunction in patients with acute pulmonary thromboembolism. However, Qanadli score was superior to Miller and Walsh score for two reasons. The statistical significance of the Qanadli score (0.000000056) was slightly more compared to Miller (0.000657112) and Walsh score (0.0000809031). In addition the calculation of the Qanadli score is easier to deduce and more reliable and reproducible. Further prospective studies are needed to delineate the usefulness of the Qanadli score to identify patients with RV dysfunction in patients presenting with acute pulmonary thromboembolism.

CONCLUSION

Thus the present study showed that the three angiogram based scoring system (Miller, Walsh and Qanadli) were able to accurately identify patients with RVD in acute pulmonary thromboembolism. Of these three scoring system the Qanadli score was the better predictor of RVD and it was the more reliable and easily reproducible scoring system.

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