ASSESSMENT OF RIGHT VENTRICULAR FUNCTION BY ECHOCARDIOGRAPHY IN PATIENTS WITH SUB MASSIVE PULMONARY EMBOLISM IN A TERTIARY CARE CARDIAC HOSPITAL: A CASE SERIES STUDY

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ABSTRACT

Objective: To assess right ventricular function by echocardiography in 57 cases of hospitalized patients with Pulmonary Embolism.

Study Design: Descriptive cross-sectional study.

Place and Duration of Study: Adult Cardiology Department of AFIC & NIHD from 1st October 2017 till 31st December, 2019.

Material and Methods: 57 patients with pulmonary embolism were included in the study using consecutive sampling technique. Clinical characteristics and outcomes of the patients were noted and analyzed. SPSS-23 was used for data analysis.

Results: Fifty Seven (57) cases of acute pulmonary embolism (based on CT pulmonary angiography) were included in our study and were admitted to the coronary care unit of hospital during the study period. Mean age of patients was 43.64 ± 17.8 years with minimum age 20 years and maximum 83 years. There were 47 (82.5%) male while 10 (17.5%) female patients. Most common New York Heart Association (NYHA) class with which patients presented was, class IIIin 27 (47.5%) followed by class IV in 15 patients (26.3%). The most common CT Pulmonary Angiogram finding of the patients was bilateral segmental embolism seen in 34 patients (59.64%). Out of 57 patients, 22 (38.6%) patients received streptokinase and ten (17.5%) received tissue plasminogen activator. Four patients were found to have deep venous thrombosis. Mortality was 12.3% (n=7). On 2D echocardiography, mean Pulmonary Artery Pressure (PAP) was 27.88 ± 19, mean RV size 41.56 ± 7 and mean RV/LV size ratio was 0.97 ± 0.15. Mean Tricuspid annular plane systolic excursion (TAPSE) as measure of right ventricular systolic function was 17.37 ±. Mortality was higher in patients with TAPSE less than 18.

Conclusion: Acute pulmonary embolism is a relatively common medical emergency and accurate diagnosis in early period can help institute appropriate thrombolytic therapy to maximally benefit the patients. Right ventricular function can be assessed by echocardiography at bed side and its dysfunction correlates with prognosis and mortality in pulmonary embolism.

Keywords: Pulmonary embolism, NYHA class, CT Pulmonary Angiogram, Deep venous thrombosis, pulmonary artery pressure, right ventricular function, TAPSE

INTRODUCTION

Pulmonary embolism (PE) is a relatively common cardiovascular emergency occurring in 60 to 112 of every 100,000 individuals[1]. About 430,000 people each year in Europe are affected by pulmonary embolism. In the United States between 300,000 and 600,000 cases occur each year, which results in between 50,000 and 200,000 deaths[2]. Rates are similar in males and females. They become more common as people get older. It is the third most common cause of cardiovascular mortality and is responsible for 100,000 to 180,000 deaths annually[1]. The prevalence of Pulmonary embolism among hospitalized patients in the United States, according to data collected between 1979 and 1999, was 0.4% though only 40–53 per 100 000 persons were diagnosed with Pulmonary embolism per year[3]. Massive acute pulmonary embolism remains a

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life threatening event associated with significant morbidity and mortality.

PE is commonly classified as massive (high-risk), sub-massive (intermediate-risk) and low risk to help determine the required treatment. Massive PE is defined as suspected or confirmed PE in the presence of shock, sustained hypotension, pulselessness or persistent profound bradycardia. Sub-massive PE is defined as suspected or confirmed PE with right ventricular dysfunction in the absence of shock[5,9]

Pulmonary embolism and deep venous thrombosis are two clinical presentations of venous thromboembolism (VTE) and share the same predisposing factors. In most cases pulmonary embolism is a consequence of DVT. Among patients with proximal DVT, about 50% have an associated, usually clinically asymptomatic pulmonary embolism at lung scan[5,7,8]. In about 70% of patients with Pulmonary embolism, DVT can be found in the lower limbs if sensitive diagnostic methods are used[7]. The risk of death related to the initial acute episode or to recurrent PE is greater in patients who present with Pulmonary embolism than in those who present with DVT. According to prospective cohort studies, the acute case fatality rate for Pulmonary Embolism ranges from 7 to 11%[11,24,25]. Although pulmonary embolism can occur in patients without any identifiable predisposing factors, one or more of these factors are usually identified (secondary Pulmonary embolism). The proportion of patients with idiopathic or unprovoked Pulmonary embolism was about 20% in the International Cooperative Pulmonary Embolism Registry (ICOPER)[24,25]. Patient-related predisposing factors include age, history of previous VTE, active cancer, neurological disease with extremity paresis, medical disorders causing prolonged bed rest, such as heart or acute respiratory failure, and congenital or acquired thrombophilia, hormone replacement therapy and oral contraceptive therapy[20,21,22]. Indirect echocardiographic signs of acute pulmonary embolism include dilated right atrium (RA) or right ventricle (RV), bowing of the inter-atrial septum, tricuspid regurgitation (TR) as well as under-filling of the left ventricle (LV)[6,23].

MATERIAL AND METHODS

A descriptive cross-sectional study was carried out at Armed forces Institute of Cardiology (AFIC & NIHD) Rawalpindi from 1st October 2017 till 31st December, 2018. A total of 57 patients of pulmonary embolism were included in the study, using consecutive sampling technique. Data collection tool was used to collect the different variables. Data was entered analyzed using SPSS-23 Version.

RESULTS

Fifty sevencases of acute pulmonary embolism were included in thestudywho were admitted in the coronary care unit (CCU) during our study period. Mean age of patients was 43.28 ± 17.6 years with minimum age 20 years and maximum 83 years. There were 48 (84.20%) male patients while 9 (15.80%) female patients. Most common NYHA class with which patients presented was, class III in 21 (36.80%) followed by class IV in 11 patients(19.30%). The most common CT Pulmonary Angiogram finding of the patients was bilateral segmental embolism in 34 patients (59.64%). Out of 57 patients, 22 (38.59%) patients received streptokinase and ten (17.50%) received tissue plasminogen activator. Four patients were found to have deep venous thrombosis. Right ventricular systolic function was assessed echocardiographically by RV dilatation, TAPSE, pulmonary artery pressure measurement and RV/LV ratio. On 2D echocardiography, mean Pulmonary Artery Pressure (PAP) was 27.88 ± 19, mean RV size 41.56±7 and mean RV/LV size ratio was 0.97 ± 0.15. Mean Tricuspid annular plane systolic excursion (TAPSE) as measure of right ventricular systolic function was 17.37±. Mortality was 12.28 % (n=7). Chi-square test was applied to find out the association between mortality and different variables. Results showed that only NYHA class and TAPSE findings were statistically significant ($p<0.05$) with mortality as shown in table-I. Pearson correlation was seen insignificant in

echocardiographic variables (table-II). Independent sample t-test and chi-square test was applied for association between ofTAPSE, RV size, LV size and mortality as shown in table-III. Measured parameters of RV and LV function diameters and RV differed significantly between patients with TAPSE ≤18 mm or TAPSE ≥18 mm. RV diameter was significantly larger in the TAPSE ≤18 mm population compared to the TAPSE ≥18.

Table-I: Demographic characteristics of patients with sub-massive pulmonary embolism.

Variables	n (%)	Outcomes		*p*-value
		Dead	Alive	
Gender				
Male	47 (82.5)	42 (84%)	5 (71.4%)	0.56
Female	10 (87.7)	8 (16%)	2 (28.6%)	
NYHA				
I	6(10.5)	6 (12%)	0 (0%)	
II	9(15.7)	8 (16%)	1 (14.3%)	<0.001*
III	27(47.5)	23 (46%)	4 (57.1%)	
IV	15(26.3)	13 (26%)	2 (28.6%)	
Treatment				
Heparin+SK	22(38.6)	16 (32%)	6 (85.7%)	<0.001*
Heparin	25(43.9)	25 (50%)	0 (0%)	
TPA	10(17.5)	9 (18%)	1 (14.3%)	

n=frequency, %=percentage

Table-II: Echocardiographic derived correlation of TAPSE with Right and Left ventricle size.

Variables	TAPSE* (18.0 ± 8.1)	Pearson correlation R	p-value
RV size	41.5 ± 7.0	-0.046	0.76
LV size	43.1 ± 4.1	-0.283	0.06

*TAPSE = Tricuspid Annular Plane Systolic Excursion

DISCUSSION

Massive PE was previously defined by anatomical criteria: >50% obstruction of pulmonary vasculature or occlusion of 2 or more lobar arteries. It is now more commonly defined by hemodynamic instability, which is a function of both PE size and underlying cardiopulmonary status. Massive acute pulmonary embolism is now defined as sustained hypotension (systolic blood pressure <90 mmHg for at least 15 min or requiring inotropic support not due to a cause other than PE such as arrhythmia, hypovolemia, sepsis or LV dysfunction), pulselessness, or persistent profound bradycardia (heart rate <40 bpm with sign and symptoms of shock)[5,6].

Acute pulmonary embolism leads to an abrupt rise in pulmonary vascular resistance. Right ventricular contractile function is compromised, and right ventricular failure ensues. This vicious cycle of cardiogenic shock is augmented by concomitant hypoxia, which inevitably leads to cardiovascular collapse.The interval from the onset of symptoms to death is relatively short. In patients with massive pulmonary embolism, 50% die within 30 minutes, 70% die within 1 hour, and more than 85% die within 6 hours of the onset of symptoms. Therefore, the window for obtaining a definitive diagnosis is small. In an optimal setting, the diagnosis of pulmonary embolism can be made on the basis of the history and physical examination along with selective tests, such as electrocardiography (ECG) to rule out myocardial

infarction, chest radiography to rule out pneumothorax, and an arterial blood gas analysis to strengthen the diagnosis[22]. When the diagnosis of massive pulmonary embolism is made, medical or surgical treatment must be initiated immediately. If the patient is in extreme hypotension, the decision to perform embolectomy may be made primarily on clinical impression.Thrombolysis is also an established therapy for massive pulmonary embolism[19,21,26].

Definitions of sub-massive PE vary in literature and intermediate risk PE is sometime used in preference to 'sub-massive'. It is defined as acute PE without systemic hypotension (SBP >90 mmHg but with RV dysfunction or myocardial necrosis)[26]. In PEITHO trial intermediate risk PE was defined as presence of RV dysfunction or a positive Troponin[19]. In MOPPET trial moderate PE was defined as the presence of signs and symptoms of PE plus computed tomographic pulmonary angiographic involvement of >70% involvement of thrombus in >2 lobar or left or right main pulmonary arteries or by a high probability ventilation/perfusion scan showing ventilation/perfusion mismatch in >2 lobes[10,20]. Sub-massive PE accounts for 20% of all PEs with in-hospital mortality of 2-5%. There is evidence from registries Data that short term mortality rate directly attributable to sub-massive PE treated with Heparin anticoagulation is pobably < 3%. It accounts for most deaths from PE, leads to long term morbidity especially chronic pulmonary hypertension and worst functional outcome. Cho et al found that haemodynamically stable patients with PE, 37% have RV dysfunction on echo and also found higher short term mortality in this group. (Odds ratio 2.29; 13.7 vs 6.5 without RV dysfunction). RV dysfunction and elevated Troponins are also predictors of poor outcome in sub-massive PE[23]. As such a smaller PE in a patient with poor cardio-pulmonary reserve could produce similar outcomes to a larger PE in a patient without prior cardiopulmonary disease[22].

The present study was conducted to document role of echocardiography in sub-massive pulmonary embolism with particular reference to right ventricular (RV) systolic function measured by tricuspid valve annular plane systolic excursion(TAPSE) and also RV dilatation, indirect pulmonary artery systolic pressure measurement and tricuspid regurgitation.Failing RV is the most important cause for mortality in acute pulmonary embolism, an accurate and quick assessment of its function can be critically important and potentially life saving. Echocardiography has become increasingly importantinin RV functional assessment.

Table-III: Comparison of RV/ LV sizes and their mortality with two TAPSE groups

Parameters	TAPSE* ≤18mm	TAPSE ≥18mm	*p*-value
LV size	43.2 ± 4.1	43.0 ± 4.5	0.87
RV size	42.5 ± 6.8	37.9 ± 6.7	0.04*
Outcome			
Alive	38 (66.7%)	12 (21.1%)	0.32
Died	7 (12.3%)	-	

*TAPSE = Tricuspid Annular Plane Systolic Excursion

TAPSE is a widely recognized, easily obtainable and clinicalyy useful echocardiographic measure of global RV function and has been shown to have prognostic value in patients with pulmonary embolism. The value of TAPSE as a highly sensitive and specific parameter reflecting RV global function has been studied by various researchers.In our study, TAPSE less than 18 correlated with RV dilatation and higher mortality[30-32].

CONCLUSION

Cardiologists may be asked to manage patients with massive and sub-massive PE

because cardiovascular medical specialists are trained to treat hemodynamic derangements with a variety of interventional and pharmacological approaches. A rapid and accurate assessment of risk and a decisive treatment plan should be established. 2 D echocardiography can be used quickly to assess right ventricular systolic finction and prognostication. Fortunately, fibrinolysis, catheter intervention, and possible collaboration with cardiac surgeons for desperately sick patients are tools that will assist cardiovascular specialists in maximizing the likelihood of prompt and complete recovery in these seriously ill patients.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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