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Prognostic Value of Echocardiography in Normotensive Patients With Acute Pulmonary Embolism

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OBJECTIVES The goal of the study was to evaluate the prognostic value of echocardiographic indices of right ventricular dysfunction (RVD) for prediction of pulmonary embolism–related 30-day mortality or need for rescue thrombolysis in initially normotensive patients with acute pulmonary embolism (APE).

BACKGROUND There is no generally accepted echocardiographic definition of RVD used for prognosis in APE.

METHODS We studied the prognostic value of a set of echocardiographic parameters in 411 consecutive patients (234 women, age 64 ± 18 years) with APE hemodynamically stable at admission.

RESULTS Thirty-day APE-related mortality was 3% (14 patients), all-cause mortality was 5% (21 patients). Nine patients received thrombolysis as a result of hemodynamic deterioration, and 7 of them survived. The clinical endpoint (CE), which included APE-related death or thrombolysis, occurred in 21 patients. At univariable Cox analysis, the hazard ratio (HR) for CE of the right ventricular (RV)/left ventricular (LV) ratio was 7.3 (95% confidence interval [CI]: 2.0 to 27.3; $p = 0.003$). However, multivariable analysis showed that tricuspid annulus plane systolic excursion (TAPSE) was the only independent predictor (HR: 0.64, 95% CI: 0.54 to 0.7; $p < 0.0001$). Moreover, the area under the curve (AUC) in receiver-operating characteristic analysis for TAPSE (0.91, 95% CI: 0.856 to 0.935; $p = 0.0001$) in CE prediction was higher ($p < 0.001$) than AUC of RV/LV ratio (0.638, 95% CI: 0.589 to 0.686; $p = 0.001$). TAPSE ≤15 mm had a HR of 27.9 (95% CI: 6.2 to 124.6; $p < 0.0001$) and a positive predictive value (PPV) of 20.9% for CE with a 99% negative predictive value (NPV), whereas TAPSE ≤20 mm had a PPV of 9.2 with a 100% NPV. RV/LV ratios of >0.9 and >1.0 had a PPV of 13.2% and 14.4% and a NPV of 97% and 94.3%, respectively.

CONCLUSIONS TAPSE is preferable to the RV/LV ratio for risk stratification in initially normotensive patients with APE. TAPSE ≤15 mm identifies patients with an increased risk of 30-day APE-related mortality, whereas TAPSE >20 mm can be used for identification of a very low-risk group. (J Am Coll Cardiol Img 2014;7:553–60) © 2014 by the American College of Cardiology Foundation

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Although short-term prognosis in acute pulmonary embolism (APE) predominantly depends on the patient's hemodynamic status and comorbidities (1,2), right ventricular dysfunction (RVD) and injury also have a significant prognostic value in hemodynamically stable APE patients (3–5). Right ventricular (RV) enlargement, detected at echocardiography in approximately 30% of normotensive patients with APE (6–8), is regarded as a predictor of poor clinical outcome, even in initially stable patients. American Heart Association guidelines on submassive pulmonary embolism arbitrarily proposed that RVD should be diagnosed when the right ventricular to left ventricular (LV) end-diastolic ratio (RV/LV) measured by echocardiography or tomography exceeds 0.9 (1). However, a wide range of criteria for RVD on echocardiography were used in different studies (1,2,9,10). Moreover, to our knowledge, no direct comparison of echocardiographic criteria for short-term risk prognosis in APE is available. Therefore, we analyzed the prognostic value of clinically used echocardiographic parameters of RVD for prediction of pulmonary embolism (PE)-related 30-day mortality or need for rescue thrombolysis in initially normotensive patients with APE, and compared their prognostic value with the value of RV/LV ratio, the most frequently used RVD parameter.

ABBREVIATIONS AND ACRONYMS

APE = acute pulmonary embolism

AUC = area under the curve

CE = clinical endpoint

CI = confidence interval

HR = hazard ratio

LV = left ventricle/ventricular

NPV = negative predictive value

PPV = positive predictive value

ROC = receiver-operating characteristic

RV = right ventricle/ventricular

RVD = right ventricular dysfunction

TAPSE = tricuspid annular systolic plane excursion

MATERIALS AND METHODS

Patients and management of APE. The study group comprised 411 consecutive patients with symptomatic APE, hemodynamically stable at admission, who were diagnosed and treated in our department. PE was confirmed by contrast-enhanced multidetector computed tomography when thromboemboli were visualized in an at least segmental pulmonary artery. On admission, all patients had a systemic systolic blood pressure of at least 90 mm Hg and showed no signs of peripheral hypoperfusion. APE was diagnosed when symptoms of PE had been present for no longer than 14 days before the diagnosis. Patients with diagnosed chronic thromboembolic hypertension and participants in therapeutic clinical trials were not included in this study.

Echocardiography. Routine transthoracic echocardiography for the assessment of RVD was performed and interpreted according to a standardized protocol by an experienced physician using a Philips iE33 or Philips HD11XE system (Philips Medical Systems, Best, the Netherlands), as soon as possible after admission. The examinations were digitally recorded. RV and LV diastolic diameters were measured in the parasternal long-axis view. In the apical 4-chamber view, LV and RV diastolic diameters were measured at the level of the mitral and tricuspid valve tips during late diastole (defined by the electrocardiogram R-wave), and the presence of McConnell's sign was assessed (11,12). Left ventricular ejection fraction was assessed using Simpson's method (13). Tricuspid annular plane systolic excursion (TAPSE) was assessed in the M-mode presentation by placing a cursor in the tricuspid annulus and measuring the amount of longitudinal motion of the annulus at peak systole (12). Tricuspid valve regurgitation was qualitatively assessed by color Doppler, and peak gradient was calculated using a simplified Bernoulli's formula, using tricuspid regurgitant flow peak velocity. In the short parasternal axis, flattening of the interventricular septum was assessed qualitatively, and acceleration time of pulmonary ejection and peak pulmonary valve systolic velocity were measured in the RV outflow tract, proximal to the pulmonary valve. The examination was completed by measurement of the inferior vena cava at late expiration.

Echocardiography was performed immediately on admission in 193 patients, within 24 h in 159 patients, and between 24 and 72 h after admission in 59 patients.

Submassive (intermediate-risk) APE was diagnosed when RVD was diagnosed at echocardiography, whereas the remaining subjects formed the low-risk group. Pre-defined RVD was diagnosed when echocardiography showed: 1) RV free wall hypokinesis and RV/LV >0.9 in the 4-chamber apical view; and/or 2) an elevated tricuspid valve pressure gradient exceeding 30 mm Hg with a shortened acceleration time of pulmonary ejection below 80 ms.

The clinical endpoint (CE) of the study was defined as a combination of 30-day APE-related mortality and/or rescue thrombolysis in patients with hemodynamic deterioration, which was defined by occurrence of at least 1 of the following: 1) the need for cardiopulmonary resuscitation; 2) systolic blood pressure below 90 mm Hg for at least 15 min, with signs of end-organ hypoperfusion; or 3) the need for intravenous catecholamines in vasopressor doses.

This observational study was approved by the local ethics committee.