Acute kidney injury in intensive care COVID-19 patients: a monocenter retrospective study

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PATIENTS AND METHODS

Echocardiography

To evaluate cardiac function, we used transthoracic echocardiography performed by trained operators (competent in advanced critical care echocardiography) [1] using Vivid S70 and Vivid E9 systems(GEMS, Boston, MA)with a standard procedure [2]. Briefly, the following echocardiographic views were examined: four-chamber and two-chamber long-axis views to assess left ventricle ejection fraction (LVEF, computed from LV volume using bi-plane Simpson method [1] when image quality was good, or visually estimated when image quality was not sufficient to identify the endocardium) [2], tissue Doppler peak systolic wave at the lateral valve annulus of mitral and tricuspid valves[3], right ventricle size (a dilated RV was defined by a RV/LV end-diastolic area ratio ≥0.6)[4], long-axis M-mode view of the inferior vena cava to assess its maximal diameter [5], LV filling pressures [using pulsed-wave Doppler early (E) and late (A) diastolic wave velocities at the mitral valve, and tissue Doppler early (e') diastolic wave velocity at the lateral mitral valve annulus][6]. Pulsed-wave Doppler flows were obtained at the aortic valve to assess aortic velocity-time integral for cardiac output computation.Pulmonary circulatory system dysfunction was classified absent when pulmonary artery systolic pressure was <40 mmHg with normal right ventricle size and normal septal kinetics; moderate if pulmonary artery systolic pressure was ≥40 mmHg, orin case of dilated right ventricle,or septal dyskinesia without cor pulmonale; or severe in case of cor pulmonale (association of dilated right ventricle or septal dyskinesia) [7]. Echocardiographic images were digitally stored, and a computer-assisted evaluation was performed off-line by two trained operators (FB, PM). Echocardiography was performed within 72 hours of intensive care unit admission. All measurements were averaged over a minimum of three cardiac cycles (five to ten in case of non-sinus rhythm).Apical long-axis (four- and two-chamber) clips underwent on-line speckle tracking analyses by two trained operators (FB, PM). The average of three consecutive heart cycles was used to calculate global longitudinal peak systolic strain of the LV.

Assessment of contractility and loading conditions

Preload was assessed using estimates of LV filling pressures (E/A and E/e' ratios) [6]and maximum diameter of inferior vena cava [7]. Afterload was assessed using the following indices: ii) systemic vascular resistance (the most commonly used measurement of vascular tone)= $\frac{80*meanarterialpressure\ (mmHg)}{cardiacoutput(L.min^{-1})}$[8];and ii) end-systolic arterial elastance (to reflect the pulsatile component of peripheral load)= $\frac{systolicarterialpressure\ (mmHg)}{strokevolume\ (mL)}$[9–11].

LV systolic function was assessed using indices obtained by two-dimensional echocardiography (to calculate LVEF), tissue Doppler imaging (tissue Doppler peak systolic wave at the lateral mitral valve annulus), speckle tracking imaging (global longitudinal peak systolic strain of the LV), and two additional indices to reflect net cardiovascular performance and heart-arterial interaction, respectively, as:

i) LV end-systolic maximal elastance = $\frac{systolicarterialpressure\ (mmHg)}{LVend-systolicvolume\ (mL)}$[12,13], and ii) ventricular-arterial coupling, which is the ratio of LV end-systolic maximal elastance and end-systolic arterial elastance, namely = $\frac{stroke\ volume(mL)}{LVend-systolic\ volume\ (mL)}$[13]. LV end-systolic volume was obtained from the Simpson method [3] and stroke volume was derived from left ventricle outflow track diameter and aortic velocity-time integral.

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