

Early assessment of ventricular strain after coronary artery stenting predicts adverse myocardial remodeling in patients who have recovered from COVID-19

Background. Speckle-tracking echocardiography (STE) is a method of assessing global and regional myocardial contractility. During the pandemic of the novel coronavirus infection, numerous evidences of its sensitivity to changes in the systolic function of the myocardium in the acute period of COVID-19 of varying severity were obtained. Whether such changes have long-term consequences, and whether there is a connection between myocardial strain and residual inflammation and endothelial dysfunction (ED), remains unknown.

Aim. Evaluate the prognostic potential of changes in STE parameters after stenting of CA in patients who have recovered from COVID-19.

Methods. In 2021, 152 patients (70% men) with ACS (STEMI, NSTEMI) admitted to the Central Clinical Hospital were included. All underwent Judkins coronary angiography and percutaneous coronary intervention with DES implantation in the infarct-related coronary artery (IRCA). Damage to the LCA trunk was a criterion for exclusion from the study. The patients were divided into two groups: the main group (MG-77 patients), who suffered from COVID-19 2-6 months ago, and the control group (CG-75 patients), who were not infected with SARS-CoV-2. The groups were comparable in terms of sex, age, clinical and demographic characteristics, comorbidities. Echocardiography was performed on a US scanner Philips (USA) according to the standards of international cardiology societies. To analyze the deformation and rotational properties of the myocardium, two-dimensional echocardiographic images were recorded at a frame rate of 60-80 frames per second from the apical access in 4-, 2-, and 3-chamber positions. Images along the short axis of the LV at the level of the leaflets of the mitral valve, at the level of the papillary muscles and at the level of the apex of the LV were also obtained from the parasternal approach. Global longitudinal strain (GLS), circumference strain (GCS) and radial strain (GRS) of the left (LV) and right (RV) ventricles were studied. In the blood, along with markers of myocardial damage (troponins, NT-proBNP), markers of inflammation and endothelial dysfunction (CRP, ET-1) were determined. Statistical

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data processing is carried out in IBM SPSS 20.0.

Results. The groups did not differ in the extent of CA damage: 80% had multivessel CAD, 20% had single-vessel CAD. There were differences in the morphology of the IRCA lesions: in CG, the cause of ACS in all patients was the rupture of hemodynamically significant (stenosis 76%) atherosclerotic plaque (ASP), in MG every third patient had a rupture of hemodynamically insignificant ASP (stenosis 43%). No differences between the groups were found in the frequency of IRCA damage: LAD occlusion was detected in 54.2% and 64%, RCA – in 33.3% and 25%, LCA – in 12.5% and 11% of cases. In CG, lesions were more often localized in the proximal third, in MG – in the middle third of the IRCA. 75% and 70% of them belong to the type "A" according to the ACC/AHA classification, and 25% and 30% to the type "B", respectively. A total of 165 stents were implanted. The average length of the atherosclerotic lesion (21.87 ± 4.15 mm and 23.06 ± 3.71 mm) and the average diameter of the ISC (3.22 ± 0.35 mm and 3.19 ± 0.40 mm) did not differ. TIMI 3 was achieved in CG in 95% of patients, in MG – in 88%.

In the early period after PCI, the structural indicators of the LV and the parameters of its diastolic filling did not differ. According to the results of STE, it was established that the parameters of RV strain were worse in persons who had undergone viral pneumonia than in persons with a mild COVID-19, as well as in persons with CG. In patients with elevated CRP (6.5 [5.8; 11.4] mg/l), ET-1 (4.09 [3.68; 7.04] pg/ml), D-dimer (642 [530; 875] ng/ml), signs of pulmonary hypertension were revealed after 12 months. Regional LV strain in patients of the CG was disturbed in ischemic or stunned segments, was observed in the first 48 hours after PCI and improved at the first follow-up visit after 3 months. This indicates that residual myocardial ischemia was the cause of the decrease in LV strain in the CG. Diastolic

dysfunction of the myocardium (DDM), caused by ischemia, was also eliminated after the restoration of coronary blood flow. However, in persons with LV hypertrophy, it remained at the subclinical level throughout the entire observation period, without progressing to HFpEF.

In patients who suffered from COVID-19, LV strain disorders were detected at the regional and global levels. Initially decreased LV GLS (17.5%) and LV GCS (16.7%) increased 3 months after IRCA stenting. However, in patients with residual inflammation (CRP 6.2 [5.6;11.0] mg/l) and ED (ET-1 4.25 [5.6;11.0] pg/ml), decreased LV strain remained unchanged after 3 months.

After 6 months after PCI, every fifth patient with MG had signs of diffuse endomyocardial fibrosis, which was a consequence of viral myocarditis. 16.5% was taken as a cut-off prognostic value of GLS LV. After 6 months, NT-pro-BNP exceeded the threshold value of 125 pg/ml in 40% of people who had been infected with COVID-19 (in CG – in 25%), in 26% after 12 months, LV EDV increased (in CG – in 15%), which was accompanied by a 10% decrease in LV EF. After 12 months, in half of the patients with MG with initial decrease in GCS LV and increased expression of ET-1, AH, LV hypertrophy, DDM, HFpEF were revealed. Patients with insulin resistance and obesity were at risk. In the case when the decrease in the LV GLS and LV GRS was preserved for at least 6 months, in the presence of persistent inflammation, ED, obesity and diabetes, the dimensions of the heart chambers increased after a year, the LV EDV exceeded 75 ml/m^2 , which led to the deterioration of the LV systolic-diastolic function, progression of coronary atherosclerosis, development of CHF.

Conclusions. The initial decrease in RV strain in patients with ACS, which is not eliminated after stenting of the IRCA, is apparently a consequence of ED and the formation of microthrombus in small-

diameter pulmonary vessels caused by residual inflammation after suffering from COVID-19. Absence of improvement of global strain of RV within 3 months after revascularization of myocardium in combination with increased level of ET-1 indicates probable pulmonary hypertension. Preclinical violation of global and regional LV contractility and the absence of expected improvement in LV strain indicators after myocardial revascularization in patients who have suffered from COVID-19 may be the result of a violation of myocardial microcirculation, the possible cause of which was viral myocarditis with an outcome in subendocardial fibrosis. Unfavorable LV remodeling is a

consequence of residual low-intensity inflammation and ED, which at the level of myocardial perfusion could neutralize the positive effects of IRCA stenting. Manifestation of AH, LV hypertrophy, DMD one year after stenting of an IRCA in patients with no improvement in systolic LV GLS and GCS during the first 3 months after myocardial revascularization in combination with increased expression of ET-1, demonstrates their prognostic potential for vascular and myocardial remodeling, as well as for CHF. STE can be used for early diagnosis of latent myocardial dysfunction, prognostic assessment of the effectiveness of primary PCI and adverse LV remodeling in patients who have recovered from COVID-19.