The utility of three-dimensional (3D) colour Doppler echocardiography for the evaluation of dynamic changes of secondary mitral regurgitation during dynamic stress echocardiography

Previous studies proved, that severe functional mitral regurgitation (FMR) at rest and/or its significant increase during exercise have been shown to be associated with reduced functional capacity and impaired prognosis. In these studies, FMR has been assessed using 2-dimensional (D) quantitative techniques: proximal isovelocity surface (PISA) and pulsed Doppler volumetry. These methods, however, have several known limitations. Recently, color Doppler 3-D echocardiography-derived vena contracta cross-sectional area (VCA) has emerged as a new method to assess FMR severity at rest. VCA at rest has been shown to have higher correlation with the 2-D integrative method or magnetic resonance-derived regurgitant volume than any single 2-D method. The prognostic significance of VCA at rest and its increase during exercise, however, has not been investigated. Therefore, the goal of our study was 1) to find out if the the relationship between exercise-induced changes of FMR assessed by VCA, clinical and Doppler characteristics is different from previous PISA derived ERO based studies, 2) to find resting predictors of exercise-induced changes in FMR assessed by VCA, 3) to seek for the difference between VCA and PISA methods for assessing FMR at rest and during exercise and primarily 4) to find out whether VCA at rest and its increase during exercise is an independent predictor of clinical outcome in our population. Methods: The subjects consisted of 78 patients (age, 67±12 years; 78% male) with chronic systolic heart failure and mild-moderate FMR (<2+/4) at rest. 62 patients were included for the prognostical part. All patients underwent VCA assessment at rest and during semi-supine bicycle exercise. The VCA assessment at rest and during exercise was feasible in 91% of patients, with reasonable inter-individual variability 10% on average. Results: 1) exercise induced changes in clinical and Doppler indices were not different form previous studies with VCA analysis, 2) the indices of left ventricle dyssynchrony were the only potential predictors of exercise induced significant FMR, 3) the rest-to-peak exercise difference in VCA was significantly larger than the difference in PISA-derived ERO and the exercise-induced significant increase of PISA-derived ERO (>13mm2) identified only 10 out of 24 patients (58%) with significant increase in VCA (>20mm2), with AUC for the composite endpoint 0,76 (VCA rise ≥20-mm^2) vs. 0,6 (ERO (PISA) rise ≥13mm^2), 4) during median follow-up of 17 months (IQR, 13–20 months), 15 patients (24%) had composite endpoint of all-cause death (n=3), heart failure admission (n=11), and heart transplantation (n=1). At baseline, patients with vs. without endpoint had significantly larger VCA at rest (17±6 mm^{2}vs. 13±7 mm^2, P=0.002) and at peak exercise (35±16 mm^{2}vs. 21±12 mm^2, P<0.001). On Cox regression analysis, large (≥15-mm^2) resting VCA (HR, 7.6; 95% CI: 1.93–13.02; P=0.004) and large (≥20-mm^2) exercise-induced increase of VCA (HR, 5.1; 95% CI: 1.39–15.21; P=0.014) were independently associated with composite endpoint. Concomitant presence of large VCA at rest and its large increase during exercise occurred in 53% of patients with, vs. in only 8% without endpoint (negative predictive value, 86%). Connclusion: Baseline and exercise induced clinical and Doppler indices in FMR increase vs FMR stabile were not different from previous 2D- derived indices; the presence of resting LV dyssynchrony is predictor of significant FMR during exercise; VCA analysis shows larger dynamic that the presence of relatively large VCA at rest and its significant increase during exercise is independently associated with adverse clinical outcome in patients with mild-moderate FMR at rest.