News and Views From the Literature

Cardiac Magnetic Resonance Imaging

Determinants and Functional Significance of Myocardial Perfusion Reserve in Severe Aortic Stenosis

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Cardiac magnetic resonance imaging (CMR) has emerged as an adjunct to echocardiography for the evaluation of patients with valvular abnormalities, including aortic stenosis (AS). Echocardiography is limited in patients with poor acoustic windows, is more operator dependent than other techniques, and relies on several geometric assumptions.[1] Left ventricular remodeling and exercise capacity are associated with adverse clinical outcomes in patients with severe AS. This review focuses on a recent study by Steadman and colleagues[2] to assess the association between CMR-measured indices and exercise capacity in patients with severe AS without any obstructive coronary artery disease.

A total of 46 patients with isolated severe AS were studied before aortic valve replacement. The following investigations were undertaken: cardiopulmonary exercise testing to measure aerobic exercise capacity (peak VO_2), CMR to assess left ventricular mass index (LVMI), myocardial fibrosis with late gadolinium enhancement (LGE), myocardial blood flow (MBF), and myocardial perfusion reserve (MPR). Transthoracic echocardiography was performed to assess stenosis severity and diastolic function. CMR was performed using a 1.5T scanner with retrospective electrocardiographic triggering and a 6-channel phased array cardiac coil. Standard cine views were acquired. Perfusion images were acquired after pharmacologic vasodilation with adenosine, 140 μg/kg/min, for 3 minutes and during data acquisition. A gadolinium-based contrast agent was administered intravenously (0.05 mmol/kg) at 5 mL/s and first-pass perfusion was assessed for three slices (basal, mid, and apical). Upon univariate regression analyses, peak VO_2 was associated with sex (0.41), age (0.32), MPR (0.45), resting MBF (−0.53), and septal transmitral flow velocity to annular velocity ratio (E/E = 0.34), but not with LVMI, LGE, or echocardiographic measures of AS severity. On stepwise regression analysis, only MPR was independently associated with age- and sex-corrected peak VO_2 (0.46; $P = .001$). MPR was also inversely related to New York Heart Association functional class ($P = .001$) (Figure 1). Univariate associations with MPR were sex (0.38; $P = .02$), septal E/E (0.30; $P = .03$), peak aortic valve velocity (0.34; $P = .02$), LVMI

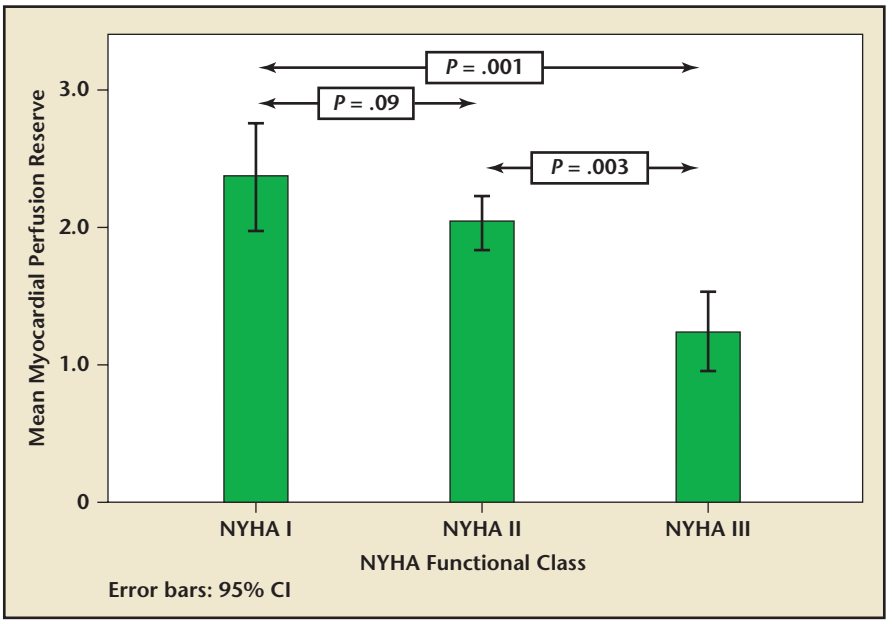

Figure 1. Relationship between myocardial perfusion reserve and NYHA functional class. CI, confidence interval; NYHA, New York Heart Association.

(0.51; $P = .001$), and LGE category (0.46; $P = .002$). On multivariate analysis, LVMI and LGE were independently associated with MPR. A mechanistic explanation of the study results could be the fact that cardiac output required for exercise is heart rate dependent in patients with an increase in severe AS, which in turn decreases the MPR.

The study highlights the potential uses of CMR in AS, including the use of MPR as a target for intervention in inoperable AS patients. However, it has several important limitations, including its cross-sectional nature and small study population. Nonlinear effects of saturation recovery and T2 losses at high bolus concentration can distort the estimated arterial input function (AIF).[3] It is unclear if the study was performed using the dual sequence method of perfusion quantification, which can minimize the error in AIF estimation. Importantly, only the five strongest univariate associations were used to obtain the final multivariate model, which mandates caution when generalizing the study results. Finally, because most patients in the study were symptomatic, universal association of MPR with exercise capacity in AS cannot be assumed. In conclusion, this is the first study to objectively evaluate exercise capacity in patients with severe AS using CMR. The study should be looked upon as a hypothesis-generating study, targeting MPR for therapeutic modulation and prognostication in AS. Further studies of clinical outcomes using quantitative CMR data to guide management are needed to enhance it as a strong tool for guiding clinical practice. ■

References

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