Is Right Ventricular Dysfunction in Obstructive Sleep Apnea a Potential Screening Tool?

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In this issue of the Journal, Tugcu et al report that by using velocity vector imaging (VVI), as well as tissue Doppler imaging (TDI), subclinical regional right ventricular (RV) dysfunction is diagnosed in patients with obstructive sleep apnea (OSA) who do not have systemic or pulmonary arterial hypertension. They found that the VVI-derived RV peak systolic myocardial velocity, strain/strain rate, and the TDI-derived RV isovolumic acceleration were significantly impaired in those with OSA, and that the RV mid free wall strain and strain rate were best correlated with the apnea hypopnea index.

Quantification of regional myocardial function is crucially important in the diagnosis of various heart diseases. M-mode echocardiography is a good old standard that has survived over the decades in daily clinical practice for cases of non-ischemic heart disease. M-mode, however, quantifies the left ventricular (LV) short-axis diameter, and therefore the results are not reliable in ischemic heart disease when regional wall motion abnormalities are present. Two-dimensional echocardiography has emerged, but quantification of wall motion remains even more problematic than in M-mode. Two-dimensional TDI was developed as a promising quantification technique in the early 1990s, but because TDI measures tissue velocity in the direction of the ultrasound beam, Doppler angle dependency, as well as the translational motion, inherently affects the measurements. At the dawn of the TDI era, Uematsu et al developed the concept of a myocardial velocity gradient (MVG), which was the inclination of the velocity profile across the myocardial wall, to quantify regional myocardial thickening. Here, the angle dependency is corrected, and the effects of translation are cancelled. The MVG was originally intended to be assessed only in the direction of myocardial thickening and thinning across the endocardium and the epicardium, the measurement of which was limited to the LV short-axis view. Urheim et al expanded the concept and introduced strain and strain rate, measured in the apical views of the LV. Application of TDI in the apical views is theoretically sound because the ultrasound is transmitted almost parallel to the LV long-axis motion, thereby making angle correction unnecessary. Strain and strain rate measurements by TDI, however, have not yet become popular among practitioners. Reproducibility issues inherently arising from the lack of tracking capability have to be overcome because TDI still has fixed sample points in most TDI machines. Displacement calculations should first be done. Speckle or pixel tracking has emerged as an alternative method in which ultrasound speckles within the image are tracked and strain is determined from the displacement of speckles in relation to each other, thereby providing an angle-independent parameter of myocardial function. VVI is an additional feature-tracking echocardiographic method, which is a derivative of speckle tracking technology that incorporates speckle and endocardial contour tracking. Because the spherical model assumption can not be applied to the RV, unlike the LV, and the myocardial wall is much thinner in the RV than in the LV, it is quite relevant to use VVI technology to assess RV regional wall motion.

Interestingly, Tugcu et al found that the conventional LV and RV measurements, such as end-diastolic and systolic diameters, LV mass index, LV ejection fraction, RV volume index etc, failed to show any differences between those presenting with OSA and control subjects in their study population, whereas VVI-derived strain and strain rate variables, together with TDI-derived RV isovolumic acceleration, were attenuated in patients with OSA. From theoretical considerations, when regional strain is generally reduced in the whole ventricle, the ejection fraction, which is the sum of the regional strains derived from the whole ventricle, should also be reduced, and hence the end-diastolic volume needs to be increased to compensate for normal output. A potential explanation for the discrepancy between the conventional and the VVI/TDI variables may include that the conventional LV and RV measurements are not accurate enough to detect the subtle differences between OSA and control subjects, whereas the TDI and VVI measurements are sensitive enough to differentiate between them. Although it is difficult to discriminate patients with OSA by these VVI/TDI variables alone because of the wide dispersion, they may have the potential to screen patients with possible OSA, as the examination can easily be done during routine echocardiography.

Although the authors excluded those presenting with pulmonary hypertension, the estimated mean pulmonary artery pressure was statistically higher in OSA than in control subjects. The difference in pulmonary artery pressure may mechanically affect RV function without compromising the RV myocardium. Interestingly, however, they also demon-
strated that the correlations between the apnea hypopnea index and VVI/TDI-derived variables remained significant, even after adjustment for mean pulmonary artery pressure. The mechanism of the impaired RV function, which was not associated with LV dysfunction in their study population, remains unknown.

OSA has been increasingly implicated in the initiation and progression of cardiovascular diseases. Patients with congestive heart failure and with diastolic dysfunction may have an especially high likelihood of OSA. Sympathetic activation, vascular endothelial dysfunction, oxidative stress, inflammation, coagulation abnormalities, and other metabolic dysregulation are considered to worsen the prognosis of heart failure in OSA subjects. On the other hand, OSA is treatable. In fact, treatment of OSA in patients with heart failure has important beneficial effects, yet OSA is still under-recognized in the cardiology community, partly because of the lack of large-scale, randomized control trials, and partly because of the tediousness of the tests to obtain the apnea hypopnea index. Hence, easy-to-use screening tests for OSA are desirable. Although they still need to be improved, the VVI- and TDI-derived variables have the potential to be an easy, practical screening test for OSA.

Finally, although it is quite logical to think that respiration and circulation are closely linked, as demonstrated in the present study, controversy still exists with regard to the association between RV dysfunction and OSA, depending on the methodology used. Further studies including a large number of patients are necessary.

Disclosure

This author has no conflict of interest to disclose.

References