Fixed versus dynamic left ventricular outflow tract obstruction: Res ipsa loquitur

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The difference in clinical management strategies for fixed versus dynamic left ventricular outflow tract (LVOT) obstruction makes this distinction clinically notable. These conditions are often encountered in the operating room and pose a dilemma requiring a multimodal approach for diagnosis and management. In their brief research report, Hong and colleagues¹ present the direct pressure and continuous wave Doppler (CWD) patterns generally observed in fixed versus dynamic LVOT obstruction, and relate these measurements to the underlying physiologic cause. Similar to aortic stenosis, fixed LVOT obstruction results in a slow and restricted aortic upstroke throughout systole, with parabolic ventricular pressure and CWD velocity curves peaking in midsystole. In contrast, dynamic LVOT obstruction results in outflow gradients and velocities that are initially near normal with a simultaneous brisk aortic upstroke that parallels the rising ventricular pressure (ie, the spike). Initial flow velocities are in the normal range. However, as the mitral valve moves closer to the septum, creating a progressive narrowing of the outflow tract, the left ventricle pressure and Doppler flow velocity begin to increase exponentially, perpetuating this cycle of obstruction. During this phase the aortic pressure remains stable as the left ventricle pressure and hence the gradient grow, peaking in late systole when the obstruction is maximal. This strengthens the notion of the push theory of dynamic obstruction in contrast to the often-cited Venturi phenomenon.²⁻⁴

Despite the distinctive patterns described above, precise differentiation can be a challenging undertaking in dynamic operating room circumstances. The time-limited nature of echocardiographic examination in the operating room requires an objective approach to assist surgical decision making. Use of serial pulse wave Doppler sample volumes can sometimes isolate the location of the step up in the velocities, suggesting the point of flow acceleration with the onset of aliasing. Use of CWD can help measure the peak velocity without any information regarding its

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Central Message

Distinguishing fixed versus dynamic left ventricular outflow tract obstruction requires synthesis of measure from multiple modalities.

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location. However, diagnosis of LVOT obstruction is a contextual decision. This requires synthesis of data from all available modalities, including careful 2-dimensional and color flow Doppler assessment of the LVOT, aortic valve, and mitral valve. For example, in addition to a high gradient, the diagnosis of dynamic LVOT obstruction is established with evidence of mitral tissue and associated color flow turbulence in the LVOT, premature closure of the aortic valve, and an eccentric mitral regurgitation jet in the presence of clinical hemodynamic instability.⁵ Similarly diagnosis of a fixed LVOT obstruction is based on visualization of an obstructing lesion. Additionally, enhanced spatial orientation with en-face 3-dimensional echocardiography views provide both qualitative and quantitative information on the mechanism, location, and severity of the obstruction.^{6,7}

This research report¹ elegantly describes the subtle differences in the hemodynamic profiles of these clinical conditions. Quite often they have similar clinical presentation that requires interpretation of hemodynamic and Doppler data with a degree of precision. Hong and colleagues¹ present a very educational case with accompanying Doppler profiles. It is important to appreciate the temporal relationship of peak velocities and gradients and the shape of the spectral Doppler profiles. It is critical that this information be interpreted in the context of clinical circumstances. Clinical decision making requires synthesizing information from multiple sources to establish an objective diagnosis. There is growing appreciation of the complex structure and function of the LVOT in normal and pathological states. Hong and colleagues¹ integration

of hemodynamic and Doppler measures of LVOT obstruction with pathophysiologic mechanisms exemplifies the power of multimodal assessment in complex clinical situations. Many physiologic and clinical questions remain unanswered with currently used methods of assessment. New diagnostic techniques such as vortex analysis⁴—as well as effective point-of-care integration of hemodynamic measures with imaging—may provide some answers and likely new questions.

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