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Echocardiographic Assessment of Aortic Stenosis Severity: Do Not Rely on a Single Parameter

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Accurate assessment of aortic stenosis (AS) severity is essential for optimal management of the patients. According to current American College of Cardiology/American Heart Association (ACC/AHA) guidelines, only patients with severe high-gradient AS and symptoms and/or reduced left ventricular (LV) ejection fraction (LVEF) have a class 1 indication for aortic valve intervention.[1] The criteria to identify severe AS are based on peak aortic jet velocity (>4 m/s) and mean transvalvular gradient (>40 mm Hg).[1] However, a large number of patients did not reach these severity thresholds and yet still may have a severe AS.[2,3] The gradient or velocity are highly flow dependent, and therefore occurrence of a low gradient/velocity despite the presence of a severe AS is often related to a reduction in LV outflow, which may be associated with reduced LVEF (classical low flow) or preserved LVEF (paradoxical low flow). This low-gradient severe AS pattern may also be observed in patients with normal flow, but the explanation for this finding is still not elucidated. Nevertheless, aortic valve replacement has been shown to be associated with better outcome in patients with low-gradient AS without regard to flow.[4,5] Hence, AS severity has to be evaluated in order to not deny or delay aortic valve replacement in a symptomatic patient with severe AS. However, the accurate evaluation of AS is challenging and requires additional imaging investigations, such as stress echocardiography or computed tomography.[2,6,7] In the current issue of the *Journal of the American Heart Association*, Kamimura et al proposed to use time to peak velocity, a variable calculated during rest echocardiography, to evaluate AS severity.[8] The rationale for the utilization of this parameter is that, attributed to calcification and rigidity of the leaflet, a severely stenotic valve would take more time to open compared to a mildly or moderately stenotic valve.

The use of acceleration time or time to peak velocity was described for the evaluation of aortic prosthetic valves[9] and was previously proposed in a small study with native AS.[10] In the present study, that included a large group of patients with native aortic valve with and without stenosis, the investigators demonstrated that time to peak velocity was associated with AS severity and predicted the composite of the need for aortic valve replacement or death.[8] However, as previously demonstrated, there is a significant overlap in time to peak velocity between moderate and severe AS.[10] In the present report, the dispersion of time to peak velocity in correlation curves well illustrates this overlap: For an indexed aortic valve area of 0.6 or a dimensionless velocity index of 0.25, the time to peak velocity that varies from 55 to 155 ms (observation restricted to patients with preserved ejection fraction). Accordingly, approximately 1 patient of 4 would have been misclassified in the 2 groups with known AS severity (ie, moderate- and high-gradient AS). Similarly, prediction of clinical outcomes appears robust in first and fourth quartiles, but inconsistent in intermediate quartiles.

This lack of accuracy in AS severity evaluation could be explained, at least in part, by the fact that the time to peak velocity is highly dependent on heart rate. Indeed, the fastest the heart rate is, the shortest the time to peak velocity is, regardless of AS severity. In order to overcome this limitation, some researchers proposed to divide time to peak velocity by the LV ejection time in series of patients with aortic bioprosthetic valves.[11] This ratio was much better than time to peak velocity to discriminate normal prosthetic valves versus prosthetic valves with significant stenosis. This ratio of time to peak velocity/LV ejection time was, however, not evaluated for assessment of severity of native AS. Another potential factor that could impair accuracy of time to peak velocity to assess AS severity is the presence of LV systolic dysfunction. Interestingly, in the present study by Kamimura et al,[8] a decrease in LVEF was independently correlated with an increase in time to peak velocity. Indeed, if the systolic

The opinions expressed in this article are not necessarily those of the editors or of the American Heart Association.

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J Am Heart Assoc. 2016;5:e004680 doi: 10.1161/JAHA.116.004680.

ventricular function is weaker or if the transvalvular flow rate is attenuated, it will take more time to open the aortic valve, regardless of the severity of stenosis. Hence, a patient with depressed LV function or reduced LV outflow may have relatively long time to peak velocity despite nonsevere AS. The dependence of the time to peak velocity vis-à-vis LV chronotropy and inotropy raises serious concerns about its usefulness in routine clinical practice. Further studies will be necessary in order to validate this parameter as well as the ratio of time to peak velocity/ejection time.

Time to peak velocity may be useful to indicate the possibility of a severe AS in case of uncertain or discordant echocardiographic results. However, this parameter should not be used in isolation and should not be used to make a definitive conclusion about AS severity. The clinical decision making in a symptomatic patient is critical and should never be based only on a single parameter. A multiparameter (morphology of the valve, velocity, gradient, aortic valve area, Doppler velocity index, peak-to-peak velocity, etc) and sometimes a multimodality (stress echocardiography, computed tomography) integrative approach is necessary to confirm AS severity in symptomatic patients.[2,6] In the highly challenging patients with discordant markers of AS severity at rest Doppler echocardiography, that is, low mean aortic gradient/aortic jet velocity despite a low aortic valve area, a multiimaging approach integrating a complete resting echocardiography, a computed tomography, and, if needed, a stress (exercise or dobutamine) echocardiography should become the standard of care.

Disclosures

None.

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Key Words: Editorials • aortic stenosis • Doppler echocardiography • evaluation • multimodality imaging