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EDITORIAL COMMENT

When the Left Ventricle Rocks

Its Causes and Relevance*

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To rock: to move back and forth in or as if in a cradle; to rouse to excitement

—Merriam Webster Dictionary (1)

The left ventricle (LV), when imaged in horizontal plane, may exhibit 3 types of motion: inward (reflective of muscle thickening); along the long axis (reflecting piston-like movement of the base); and translational (not contributing to pump function of the heart). This third type of motion has been poorly understood, largely ignored, or dismissed as a nuisance that prevented accurate estimation of cardiac function. In nature, everything happens for a specific reason. Our lack of understanding about cardiac mechanics is likely more related to our own ignorance, rather than to an absence of purpose. So what is the cause of the translational motion, and can it be relevant for diagnostic purposes?

There are 2 possible types of translational motion—linear (straight) and curved (rotational). Linear motion is demonstrated after removal of pericardial constraint. This leads to the systolic motion of the LV center of gravity from the lateral wall toward the septum, without the change in long-axis direction ("paradoxic motion of the septum"). Yet the appearance of rotational motion, where there is a noticeable change in LV long-axis direction, is more intriguing. In some disease states, the LV, when imaged in a horizontal long-axis plane, shows "rocking." This rotational motion is most easily noticed in the apex (2) and often associated with LV dilation (3). How can this phenomenon be quantitated?

Quantitation depends on 2 choices. First, one has to choose between measuring angular or tangential displacement. With rotational motion, angular is preferred over tangential displacement except for 1 uncertainty: what should be the rotational center? If rotation is limited to the apex, this center should be apically positioned. However, isolated apical rotation would result in nonphysiologic positive longitudinal strains (stretch) on 1 side and supranormal negative strains on the opposite side of the ventricle (**Figure 1**). Furthermore, rotation can actually be detected up to the mitral annulus level (4,5). For that reason, the more appropriate choice would be to use the LV center of gravity as the center of rotation, a method used when calculating "longitudinal rotation" (3) or "septo-lateral rotation" (6). However, as a center of rotation is a theoretical construct, whose position dramatically affects angular displacement (**Figure 2**), it may be more practical to focus on tangential displacement. This measure of tangential displacement was used in a study by Steelant et al. (7) published in this edition of *iJACC*. The investigators

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adroitly used the difference between displacements recorded on 2 sides of the apex to calculate true tangential displacement—a parameter they named "apical transverse motion" (2). However, this also is not an assumption-free concept, as it assumes the same length of the radius of rotation in all ventricles. Specifically, a larger ventricle will have greater tangential displacement, for the same angular displacement (**Figure 2**). Additionally, the relevance of LV "rocking" in pathologic states with normal-sized ventricles (6) could be missed if tangential displacement is used.

The second choice is between tissue Doppler and speckle tracking imaging. In this case (7), the investigators chose color tissue Doppler imaging, which is a time tested, high temporal resolution technique available on all high-end echocardiography machines. However, this method is rich in assumptions, including that the insonation vector is tangential to

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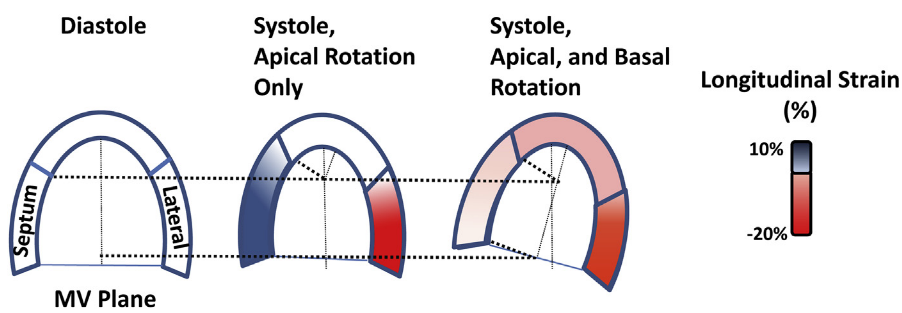
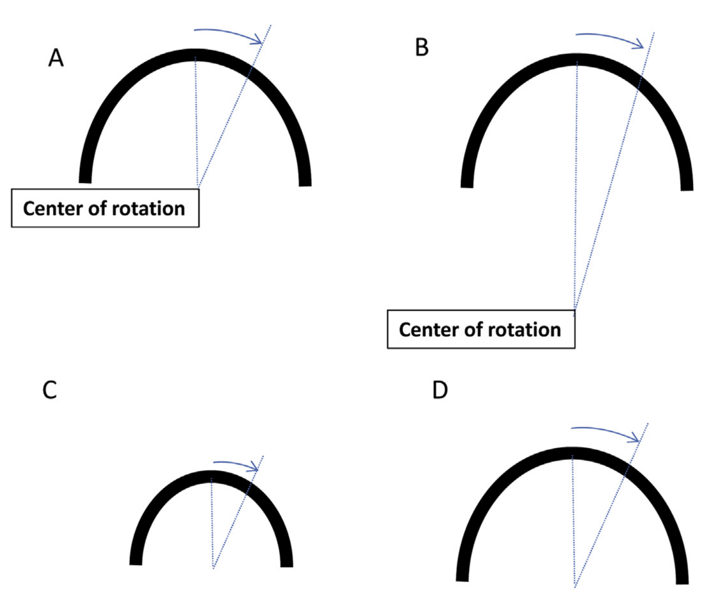
FIGURE 1 **Theoretical Impact of Isolated Apical Rotation Versus Apical and Basal Rotation on LV Strains**



Isolated apical rotation would lead to nonphysiologic stretch **(blue color)** of left ventricular (LV) septum and supranormal strain in the lateral wall **(bright red color)**. Apical and basal rotation lead to more even strain distribution, with rotational motion of mitral annular plane as previously demonstrated. MV = mitral valve.

the LV silhouette and that the 2 sample points are an identical distance from the LV apex (2). It also necessitates prospective collection of appropriate color tissue Doppler data and data manipulation using computer routines outside of the realm of a standard echocardiography laboratory (2). It is reassuring that the investigators provided supplemental data

FIGURE 2 **Impact of Center of Rotation and LV Size on Measurement of Angular Versus Tangential Displacement**



(A, B) Impact of selection of a center of rotation on angular and tangential displacement. Angular displacement is affected by the position of center of rotation, whereas tangential displacement **(arrows)** remains unchanged. Impact of small **(C)** and large **(D)** left ventricular (LV) size on angular and tangential displacement is shown. Despite identical angular displacement, there is a large difference in tangential displacement **(arrows)**.

showing that speckle tracking imaging, which is performed on any gray-scale image and is assumption-free, can result in remarkably similar data.

Should we rise to excitement in the presence of LV rocking? From the viewpoint of this practicing echocardiographer, the current paper builds on previous work for a compelling "yes." This body of knowledge demonstrates that LV rocking is strongly associated with left bundle branch block, where decreased septal and increased lateral strains lead to tangential motion of the apex from the septum toward the lateral wall in systole (2,3,7). It also shows that scar presence and burden decrease LV rocking (3,7). Furthermore, the direction of LV rocking is influenced by scar distribution in the base of the heart—its direction is always away from scar during systole. As a result, LV rocking may be detected in planes other than horizontal (2,7). Finally, LV rocking is associated with response to cardiac resynchronization therapy (CRT) (3,7). In other words, by reviewing routine LV apical views and electrocardiogram, an echocardiographer can detect whether LV dysfunction is ischemic or nonischemic, what is a scar burden and distribution, and what will be CRT response. This is a significant accomplishment considering noninvasive nature, low cost, and wide availability of an echocardiogram.

The inclusion of LV rocking in the guidelines that determine CRT candidacy is a more complex issue, for 3 reasons. The first is that dyssynchrony indices have a terrible track record in predicting CRT outcome in prospective cohort (8) and randomized (9,10) studies. One can claim that apical transverse motion is superior to previous dyssynchrony indices; however, over the last 2 decades, hundreds of dyssynchrony indices were similarly proposed, but failed to influence decision making. The second is that robust risk scores that predict most of the variability associated with CRT have already been developed. Thus, the incremental value of any additional markers will be reduced, even if they are perfect. The third is that, as investigators recognize, CRT response depends also on intraprocedural factors that no dyssynchrony assessment can predict.

In summary, recognizing LV rocking is relevant, as it is strongly associated with pathophysiologic mechanisms of LV dysfunction. Although it is unlikely that additional studies will make it a part of formal prediction of CRT response, this does not deter from its clinical usefulness. After all, we do quantitate multiple echocardiography parameters (such as left atrial size or tissue Doppler velocities) without necessarily using this information for therapy guidance.

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