JACC: CARDIOVASCULAR IMAGING
VOL. 3, NO. 3, 2010

ISSN 1936-878X/10/$36.00
PUBLISHED BY ELSEVIER INC.

iMAIL

LETTERS TO THE EDITOR

# Combining Volumetry With External Pressure Transducer

In the recent report by Schmitt et al. (1), a new combined invasive and magnetic resonance technique was analyzed for estimating end-diastolic pressure-volume (PV) relation. However, the PV estimation is limited by the need for invasive high-fidelity pressure monitoring. It appears what is missing for estimating the PV relation is not the "volume side" but the "pressure side" of the equation. It represents an even greater pathophysiological paradox when estimating diastolic left ventricular pressure (LVP) curve changes by the use of exclusively "volumetric diastolic tools," as performed currently by the imaging techniques.

We have known that an optimal external pressure transducer over the left ventricular (LV) beat can obtain recordings (pressocardiograms) that have been proven to accurately mirror LVP curve changes in time, slope, and amplitude. With the use of simultaneous high-fidelity pressocardiographic and LVP curves, it has been proven that relaxation time and above relative A-wave amplitude indexes correlate closely with corresponding LVP decay (2) and LV end-diastolic pressure or end-diastolic compliance indexes (3). Interestingly, the use of pressocardiography during short low-level isometric handgrip (HG) exercise (presso test) enables the assessment of "latent LV diastolic abnormalities" (4). More recently, we have defined pressocardiographic criteria of "ischemic" diastolic response characterized by HG-induced changes that could not be shown by the use of Doppler echocardiography (5).

We have also proposed a combined echo-pressocardiographic diastolic index in early and late diastole by using both an external pressure transducer and echocardiography at rest and during HG. At best, we could use a combined "echo-presso probe" during HG (6). It is expected that this challenging new concept will help us to assess more accurately the PV relation in clinical practice. For example, a combined "presso-A–wave and Doppler A-wave ratio" is expected to increase with decreasing LV compliance because the former would increase and the latter decrease, or the "pressocardiographic A-wave to left atrial velocity ratio" could become an index of left atrial compliance.

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doi:10.1016/j.jcmg.2009.12.007

## REFERENCES

1. Schmitt B, Steendijk P, Lunze K, et al. Integrated assessment of diastolic and systolic ventricular function using diagnostic cardiac magnetic resonance catheterization: validation in pigs and application in a clinical pilot study. J Am Coll Cardiol Img 2009;2:1271–81.
2. Manolas J, Rutishauser W. Relation between apex cardiographic and internal indices of left ventricular relaxation in man. Br Heart J 1977;39:1324–32.
3. Manolas J, Krayenbuehl HP, Rutishauser W. Use of apexcardiography to evaluate left ventricular diastolic compliance in human beings. Am J Cardiol 1979;43:939–45.
4. Manolas J. Ischemic and nonischemic patterns of diastolic abnormalities during isometric handgrip exercise. Cardiology 1995;86:179–88.
5. Manolas J, Chrysochoou C, Kastelanos S, et al. Identification of patients with coronary artery disease by assessing diastolic abnormalities during isometric exercise. Clin Cardiol 2001;24:735–43.
6. Manolas J, inventor. Device for and method of noninvasive measurement of parameters of diastolic function of left ventricle during exercise and at rest. European patent 2 067 438 A1. June 10, 2009.

## REPLY

We read with great interest the letter by Dr. Manolas regarding our report (1). Dr. Manolas correctly identifies the use of invasive pressure measurements in our approach as a limitation and proposes to replace the invasive pressure measurements by "pressocardiograms." This noninvasive methodology, also termed "apex cardiography," has a long history (2) and uses transducers placed near the apex of the heart to record the low-frequency pulsations of the chest wall produced by the beating heart. The pressocardiograms resemble ventricular pressure tracings and have been used to quantify the timing of cardiac events during the cardiac cycle. In addition, the signal and characteristic changes during exercise may be used to identify patients with ischemic heart disease and diastolic abnormalities (3).

The feasibility of this approach, by using the pressocardiography during hand-grip exercise, was examined in several studies by Manolas et al. (4). However, pressocardiograms do not provide the absolute pressure values required for our application. In fact, the tracings reflect not only intracardiac pressures but also are influenced by changes in ventricular volume, compliance, and by translations and rotations of the heart (5). Thus, it seems unlikely that changes in pressure induced by (acute) load alterations are accurately followed by pressocardiograms. Moreover, this methodology does not allow one to selectively monitor the effects of the left or the right ventricle, which is essential in our application.

In our study, systolic and diastolic pressure-volume relations of both ventricles were obtained simultaneously on the basis of invasive pressure measurements and cardiac magnetic resonance–derived steady-state ventricular volume measurements combined with aortic and pulmonary flow measurements during a rapid load intervention. The main innovative aspect of our contribution is the mathematical framework,