Validation of Noninvasive Indices Of Global Systolic Function in Patients with Normal and Abnormal Loading Conditions: A Simultaneous Echocardiography Pressure-Volume Catheterization Study

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SUPPLEMENTAL MATERIAL

CALIBRATION OF LV-MASS MEASUREMENTS

Left ventricular (LV) mass was measured with the twofold purpose of 1) computing LV wall volume to calculate end-systolic wall stress (see equation in the main article) and 2) entering LV mass as a covariate for the multivariate analysis of load confounders (Table 4) and as a illustrative variable in the principal components analysis (Figure 3). We measured LV mass using 3-dimensional echocardiography in a specific exam performed for this purpose in the 24 hours following the catheterization study, using either a Vivid 7 or a Vivid 9 system (GE Healthcare). Echo-Pac (General Electric) volumetric quantitation tools were used for processing. To ensure accuracy, were first calibrated 3D-echocardiographic measurements against magnetic-resonance sequences (1.5-T Philips Intera System, cine FISP sequences; measurements processed using QMASS software v. 7 by MEDIS).

Blindly using both techniques (< 24 hours apart), we studied a group of 20 patients with either normal hearts or nonischemic dilated cardiomyopathy (LV mass = 160 ± 55 g, range 104 to 345 g). We observed moderate correlation between modalities (R= 0.76) although there was a systematic overestimation of LV mass using echocardiography (up to 30%) that was responsible for limited agreement (intraclass correlation coefficient: 0.51). Therefore, the regression equation from this training population ($\text{Mass}_{\text{MR}} = 0.68 \cdot \text{Mass}_{\text{3D-echo}} + 13$ g) was obtained for calibration.

We tested the performance of the calibration equation in a separate group of 15 patients (LV mass = 132 ± 39 g, range 76 to 239 g). In this testing population, the agreement between values of LV mass obtained by calibrated 3D-echo and MR was now excellent: R= 0.89, intraclass correlation coefficient= 0.90 (95% CI 0.71 to 0.96), error: 1 +- 10%. Therefore, calibrated values of LV mass are used for the estimation of LV end-systolic stress as well as in Table 4 and Figure 3.

MEASUREMENT OF EJECTION INTRAVENTRICULAR PRESSURE DIFFERENCES

If the M-mode cursor closely approximates a flow streamline, the spatiotemporal velocity distribution of a discrete blood sample is provided by the value of its corresponding pixel color: $v(s,t)$, where v represents velocity, s represents the linear dimension of the streamline, and t is time. Thus, the color-Doppler M-mode recording provides the data necessary to solve Euler's momentum equation:

$$\partial p / \partial s = -\rho \left(\frac{\partial v}{\partial t} + v \frac{\partial v}{\partial s} \right)$$

where *P* is pressure and ρ is blood density. The first and second terms on the right side of the equation account for inertial and convective acceleration, respectively. Once pressure gradient maps are obtained, total, inertial, and convective EIVPDs are calculated by spatial integration between the apex and the LVOT. Instead of a fixed distance between locations, these 2 positions are traced in each image based on the grayscale layer and the pressure-gradient overlay. Peak values of EIVPD curves were measured constrained to the ejection period.

Values of flow velocity were read directly from the raw velocity data stored digitally in the General Electric proprietary DICOM tags, via hierarchical data format conversion using Echo-Pac.[1] Then velocities are semi-automatically de-aliased based on derivative thresholds. One degree of aliasing is used in image acquisition to increase dynamic range.[2] Smoothing B-splines are used for data filtering and differentiation, and the smoothing parameter has been carefully validated against high-fidelity catheters to remove noise without truncating significant EIVPD waveform features.[3,4] The accuracy of the method has been previously reported[4] and described in detail elsewhere.[5]

SUPPLEMENTAL REFERENCES

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