

SUPPLEMENTARY MATERIALS

Echocardiographic Measurements

Comprehensive echocardiographic examination was done using commercially available equipment with second-harmonic imaging and a 3.5-MHz transducer (Vivid 7, GE Medical Systems, Horten, Norway), and the data were analyzed by certified cardiologists (1). All measurements were performed following the current American Society of Echocardiography and European Association of Echocardiography guideline (2).

End-diastolic and end-systolic dimensions and the thickness of the interventricular septum and posterior wall of the left ventricle (LV) were measured in the standard parasternal short-axis view using M-mode echocardiography. Peak early diastolic velocity at the mitral valve tip (E velocity), early diastolic mitral annular velocity (e' velocity), and deceleration time of the mitral inflow were measured in the standard apical four-chamber view. Then the two velocities were divided to calculate the E/e' ratio. The mean transaortic pressure gradient and peak transaortic velocity were measured in all views possible—that is, the apical five- or three-chamber, subcostal, and right parasternal and suprasternal notch views—and the highest values were used for analysis. The time-velocity integrals at the aortic valve and the LV outflow tract levels were acquired using continuous wave and pulse wave Doppler echocardiography, respectively, and the aortic valve area was calculated by using the continuity equation with the parameters mentioned previously. All echocardiographic measurements were averaged for 3 beats for patients in sinus rhythm and for 5 beats in atrial fibrillation with a baseline heart rate of less than 100 beats per minute.

Cardiac Magnetic Resonance Imaging Acquisition and Analysis

Cine Image Acquisition and General Functional Evaluation

Balanced steady-state free precession cine images were obtained during breath holding. LV short-axis images were acquired at 10-mm intervals (6-mm thickness with a 4-mm intersection gap), from the base to the apex to include the whole LV volume using retrospective electrocardiographic gating (repetition time ms/echo time ms, 2.8–3.2/1.4–1.6; flip angle, 80°; temporal resolution, 40 ms, nine k-space lines per segment; field of view, 240 x 300 mm; matrix, 256 x 150).

The LV diastolic and systolic volumes and mass were calculated from the cine images using a dedicated semiautomatic analysis program (cvi42 version 5, Circle Cardiovascular Imaging Inc., Calgary, Canada). Papillary muscles and trabeculations were included into the LV cavity. The LV mass was measured by multiplying the sum of total LV myocardial volumes from the cine images by the specific gravity of the myocardium.

T1 Mapping Acquisition and Analysis

After acquiring the cine images, a mid-ventricular short-axis section at the papillary muscle level was acquired by using the modified Look-Locker inversion recovery, or the Modified Look-Locker inversion recovery sequence, with three images in the first two Look-Locker segments and five images for the third inversion (the “3-3-5” standard protocol). Finally, 11 images acquired during 17 heartbeats were obtained, and in-line motion correction and map generation were performed (3). The following readout parameters were used: section thickness, 6 mm; repetition time, 2.5 ms; echo time, 1.1 ms; 6/8 partial Fourier acquisition; field of view, 240 x 300 mm²; and matrix, 192 x 125.

The T1 maps were generated from the imaging workstation after in-line motion correction just after image acquisition. The region-of-interest was drawn manually at the mid-ventricular septum according to previous publications (4). The region-of-interest on the compact myocardium did not include the border of the myocardium with the LV cavity because partial volume averaging artifacts and registration error caused gradual changes in the T1 values, even after motion correction. Two radiologists (21 years and 17 years of experience in cardiac magnetic resonance imaging) performed myocardial T1 measurement while blinded to clinical and echocardiographic findings. The average of their results was used for analysis.

REFERENCES

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