Comparison of Multidetector Computed Tomography and Two-Dimensional Transthoracic Echocardiography for Left Ventricular Assessment in Patients With Heart Failure

Javed Butler, MD, MPH[a,*], Michael D. Shapiro, DO[a], Davindar Jassal, MD[b], Tomas Neilan, MD[b], John Nichols, MD[a], Maros Ferencik, MD, PhD[a], Thomas J. Brady, MD[a], Udo Hoffmann, MD, MPH[a], and Ricardo C. Cury, MD[a]

Along with coronary evaluation, 64-slice multidetector computed tomography (MDCT) permits comprehensive assessment of left ventricular (LV) anatomy and function; however, how it compares with 2-dimensional transthoracic echocardiography (TTE) in patients with heart failure (HF) is not known. In this study, we compared 25 patients with ejection fractions of <45% who underwent TTE and MDCT. The global ejection fraction by TTE versus MDCT was 36 ± 8% versus 38 ± 12% (r = 0.67, p = NS). The mean LV end-diastolic and end-systolic diameters by TTE and MDCT were 56 ± 8 and 46 ± 9 mm and 58 ± 12 and 47 ± 11 mm, respectively (r = 0.71 and 0.77, respectively, both p >0.20). The mean lateral and septal wall thicknesses by TTE and MDCT were 10 ± 1.4 and 11 ± 1.5 mm and 10 ± 1.3 and 10 ± 1.4 mm (r = 0.77 and 0.76, respectively, both p >0.20). The mean LV end-diastolic and end-systolic volumes and stroke volume by TTE and MDCT were 123 ± 45, 78 ± 31, and 44 ± 21 ml and 140 ± 58, 92 ± 43, and 48 ± 24 ml, respectively (r = 0.62, 0.67, and 0.60, respectively, all p >0.20). The regional wall motion assessment correlation was good between the 2 modalities (κ = 0.61). The interobserver correlation between the 2 MDCT readers ranged from good (r = 0.72 for LV end-diastolic volume) to excellent (r = 0.84 for septal wall thickness). In conclusion, MDCT provides comparable results to TTE for LV structure and functional assessment among patients with HF. **(Am J Cardiol 2007;99:247–249)**

Left ventricular (LV) assessment is an integral part of the management of heart failure (HF).[1] Multiple LV indexes, including global and regional function, stroke volume and cardiac output, ejection fraction (EF), wall thickness, and end-systolic and end-diastolic diameters and volumes are routinely used in the treatment of these patients.[1] Echocardiography is considered the clinical gold standard for LV assessment. Recent advances in multidetector computed tomography (MDCT) now permit accurate assessment of stenotic and nonstenotic plaques.[2–6] In addition to coronary assessment, MDCT also allows LV anatomy and function assessment.[7–10] However, these studies mostly included 16-slice scanners and patients with normal EFs. The accuracy of MDCT in patients with HF with significant wall motion and chamber abnormalities has not been studied. In this study, we sought to assess and compare LV anatomy and function among patients with HF as ascertained by transthoracic echocardiography (TTE) and MDCT.

[a]Department of Radiology and [b]Division of Cardiology, Massachusetts General Hospital, Harvard Medical School, Boston Massachusetts. Manuscript received June 6, 2006; revised manuscript received July 28, 2006 and accepted August 1, 2006.

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*Corresponding author: Tel: 617-726-5954; fax: 617-724-4152.

E-mail address: javed.butler@vanderbilt.edu (J. Butler).

Methods and Results

Twenty-five patients with an EF <45% who underwent TTE and MDCT within 4 weeks for clinical indications were studied. All patients underwent scanning with a 64-slice multidetector row scanner (Sensation 64, Siemens, Forchheim, Germany, 64 × 0.6-mm collimation, gantry rotation time 330 ms, table feed 3.8 mm/rotation, tube voltage 120 kV, tube current 850 to 950 mA) using a standard protocol. To reduce the chances of motion artifact, all patients with a baseline heart rate of >65 beats/min were given an intravenous metoprolol injection in 5-mg increments to decrease the heart rate to ≤65 beats/min or to a maximum dose of 25 mg, unless contraindicated. No complications with metoprolol use were observed. Axial images at 10% RR-interval increments throughout the cardiac cycle were reconstructed. LVEF and LV volumes were evaluated using a threshold-based technique (Circulation software, Seimens, Forchheim, Germany) by 2 independent observers blinded to the results of TTE. Each observer manually drew a line representing the mitral valve plane and then positioned a marker in the LV cavity in the previously determined end-systolic and end-diastolic phases. The software automatically calculated the LV end-systolic volume, LV end-diastolic volume, and LVEF using a threshold-based technique. Multiplanar reformatted images were reconstructed in planes corresponding to those used in TTE for other measurements (Figure 1). Regional wall motion was assessed using the 17-segment model on a 4-point scale (3 = normal, 2 = hypokinesis, 1 = akinesis, and 0 = dyski-

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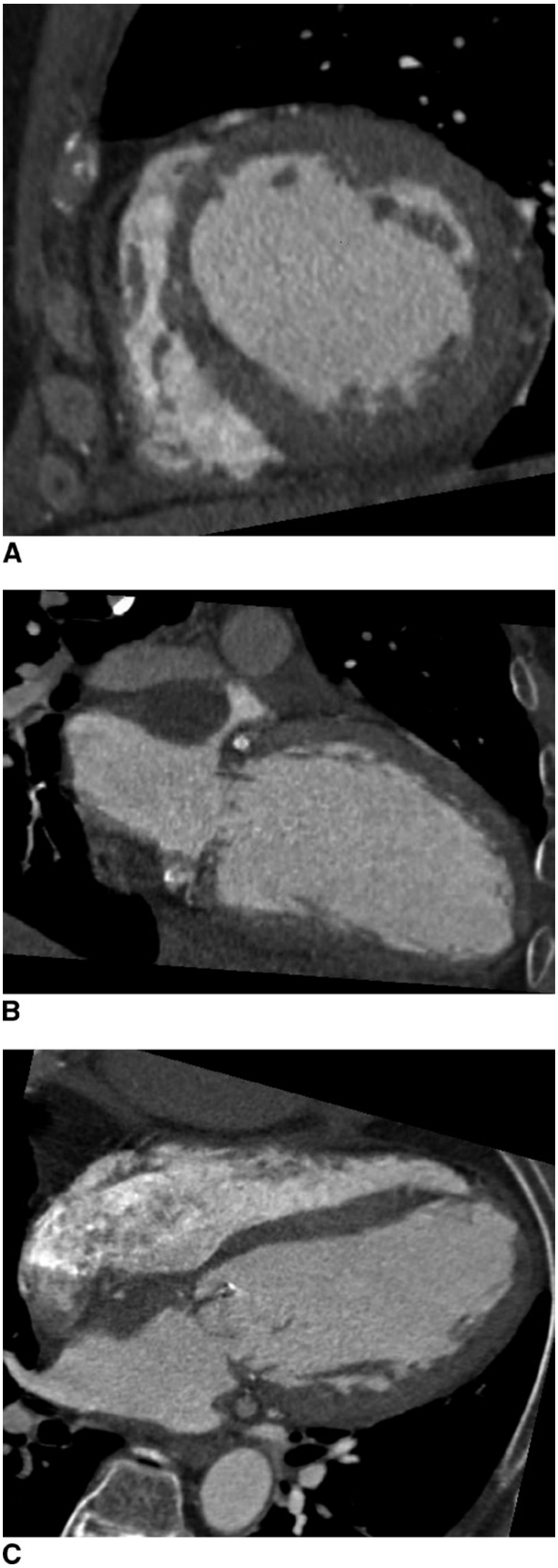

Figure 1. Short-axis *(A),* long-axis 2-chamber *(B),* and long-axis 4-chamber *(C)* views of left ventricle obtained by 64-slice MDCT in a 68-year-old man with ischemic cardiomyopathy. Images show dilated left ventricle with thinning of anterior septal wall.

nesis).[11] All patients also underwent TTE using a standard protocol. Two readers, blinded to the results of the MDCT, measured the chamber and wall dimensions using standard recommendations for chamber quantification.[12] LVEF was calculated using the single-plane Simpson's method.[13] Regional wall motion was assessed using the same protocol as used for MDCT. The estimated time needed for the detailed LV assessment using the semi-automated threshold method used in this study was approximately 5 minutes/case.

The agreement between MDCT and TTE was assessed using the correlation coefficient (r) as follows: poor = 0; slight = 0.01 to 0.20; fair = 0.21 to 0.40; moderate = 0.41 to 0.60, good = 0.61 to 0.80; and excellent = 0.81 to 1.00. The interobserver variability was assessed using Cohen's κ for categorical variables and Pearson's correlation for continuous variables. The Bland-Altman approach was used to compare the quantitative data of MDCT and TTE. The Student's *t* test was used to detect significant differences between the 2 modalities. All statistical analyses were performed using Statistical Package for Social Sciences, version 14.0 (SPSS, Chicago, Illinois).

The mean patient age was 59 $\pm$ 11 years, and 80% were men. The mean baseline heart rate was 76 $\pm$ 10 beats/min; after β-blocker administration, it was reduced to 68 $\pm$ 7 beats/min. The mean body mass index was 28.4 $\pm$ 5.8 kg/m^2. The interobserver agreement for all measurements ranged from good to excellent between the 2 readers of MDCT. The interobserver correlation of MDCT was 0.83 for EF, 0.72, 0.74, and 0.71 for LV end-diastolic volume, end-systolic volume, and stroke volume, 0.82 and 0.84 for LV end-diastolic diameter and end-systolic diameter, and 0.82 and 0.84 for the posterior and lateral wall thickness, respectively. The regional wall motion interobserver correlation was 0.83 by MDCT.

The mean EFs, volumes, chamber dimensions, and wall thicknesses obtained from TTE and MDCT are listed in Table 1. Good correlation (r = 0.67) was found between the measurements from TTE and MDCT for EF (36 $\pm$ 8% vs 38 $\pm$ 12%, p = 0.28). Bland-Altman analysis showed a trend toward MDCT resulting in slightly higher values for EF compared with TTE (mean difference 2 $\pm$ 6%). The correlation between TTE and MDCT for regional wall motion assessment based on the 17-segment model on a 4-point scale was good (κ = 0.61). The details of segmental regional wall motion correlations are listed in Table 2.

Discussion

In this study, we demonstrated that assessment by 64-slice MDCT of regional and global LV function, wall thickness, and chamber size and volumes correlates well with these measurements obtained by TTE. In general, MDCT tended to modestly overestimate the measurements, but none of these differences were statistically or clinically significant. Moreover, we demonstrated an excellent interobserver reader agreement for MDCT. These results suggest that patients with HF undergoing MDCT for coronary assessment should also have their left ventricles evaluated for anatomy and function using the raw data from MDCT.

Which patients with HF should have functional assessment performed using MDCT? Because of the ionizing

Table 1
Echocardiographic and multidetector computed tomographic-based left ventricular assessment comparison

Variable	MDCT	TEE	Correlation	p Value
LVEF (%)	38 ± 12	36 ± 8	0.67	0.28
LV end-diastolic volume (ml)	140 ± 58	123 ± 45	0.62	0.18
LV end-systolic volume (ml)	92 ± 43	78 ± 31	0.67	0.21
Stroke volume (ml)	48 ± 24	44 ± 21	0.60	0.14
LV end-diastolic diameter (mm)	58 ± 8	56 ± 5	0.82	0.39
LV end-systolic diameter (mm)	47 ± 11	46 ± 9	0.84	0.41
Interventricular septum (mm)	10 ± 1.4	11 ± 1.5	0.77	0.50
LV posterior wall (mm)	10 ± 1.3	10 ± 1.4	0.76	0.68

Table 2
Regional wall motion assessment by transthoracic echocardiography (TEE) and multidetector computed tomography (MDCT)

MDCT	TEE			
	Dyskinesis	Akinesis	Hypokinesis	Normal
Dyskinesis	6	2	0	0
Akinesis	2	77	20	3
Hypokinesis	0	20	93	33
Normal	0	0	28	141

radiation and contrast injection risks involved with the use of these scanners, we do not recommend routine use of MDCT for functional assessment in patients with HF.[2,3] The most obvious indications, however, would be functional assessment of patients who will undergo MDCT for coronary anatomy assessment, potentially for those in whom the images from TTE are inadequate, and for those with contraindications to other procedures (e.g., patients with a pacemaker who cannot undergo magnetic resonance imaging).

This was a retrospective analysis. Although image acquisition and β-blocker administration in these patients were without any problems, it could have represented a biased sample. Thus, the safety of performing MDCT in patients with HF needs to be assessed prospectively. Also, MDCT primarily provides anatomic and not physiologic information such as valvular flows and gradients. However, it was not our intent to suggest that MDCT should be considered as an alternative to TTE but that measurements obtained by MDCT correlate accurately with those obtained from TTE and should be considered as an alternative if the TTE results are suboptimal.

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