Comparison of left ventricular ejection fraction by single photon computed tomographic myocardial perfusion imaging versus coronary computed tomography angiography

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Abstract

Introduction: Measurement of left ventricular (LV) ejection fraction by coronary computed tomography angiography (CTA) vs. single photon computed tomographic myocardial perfusion imaging (MPI) needs to be investigated.
Material and methods: Myocardial perfusion imaging and CTA were performed in 292 patients because of chest pain or dyspnea. The patients included 178 men and 114 women, mean age 66 ±11 years.
Results: The mean LV ejection fraction was 61 ±12% for the MPI tests and 65 ±11% for CTA (p <0.001). The LV ejection fraction was ≥ 50% in 250 of 292 patients (86%) with MPI testing and in 266 of 292 patients (91%) with CTA ($p < 0.05$). The LV ejection fraction was 36-49% in 31 of 292 patients (11%) with MPI testing and in 22 of 292 patients (8%) with CTA (p not significant). The LV ejection fraction was ≤ 35% in 11 of 292 patients (4%) with MPI testing and in 4 of 292 patients (1%) with CTA (p not significant). Pearson correlation coefficient was $R = 0.67$, $p < 0.001$.
Conclusions: The resting LV ejection fraction is significantly higher in patients measured by CTA than in patients measured by MPI testing when both tests are performed in the same patients.

Key words: left ventricular ejection fraction, myocardial perfusion imaging, coronary computed tomography angiography.

Introduction

Numerous studies have demonstrated that an abnormal left ventricular (LV) ejection fraction is a powerful predictor of mortality [1-4]. Coronary computed tomography angiography (CTA) is being increasingly used to detect coronary artery disease and to assess LV function. This article reports comparison of measurement of LV ejection fraction by CTA vs. MPI with both tests performed in the same 292 patients with 18 days as the mean time between the 2 tests.

Material and methods

Procedure reports of patients undergoing both CTA and MPI for clinical evaluation of coronary artery disease were retrospectively reviewed. The

2 procedures were performed within 6 months of each other with 18 days as the mean time between the 2 tests. The reporters of the CTAs were blinded to the data of the MPIs and *vice versa*.

Coronary computed tomography angiography was performed using a 64-slice Siemens Somatom Sensation Cardiac scanner (Siemens Medical Solutions, Forcheim, Germany) as previously described [5]. Patients were pretreated with oral and/or intravenous β blockers to achieve heart rates < 65 beats/min. A test bolus technique was used to determine scan timing. Contrast volume was determined by scan time and flow rate. Flow rates of 4 to 6 ml/s were used. Scan collimation was 32 ±0.6 cm, with dual focal spots for each detector row to allow 64 slices per rotation [6, 7]. Rotation time was 330 ms, pitch factor 0.2, tube voltage 120 mV, and effective milliampere-seconds 750 to 850. Electrocardiographic pulsing was used to reduce radiation dose [5-7]. All studies were interpreted by 1 of 2 cardiologists experienced in CTA employing a TeraRecon Aquarius workstation (TeraRecon, Inc., San Mateo, California). Gated data were reconstructed at 5% intervals from 0 to 95% of the RR interval with 2.0 mm slice thickness and 1.0 mm increments for the purpose of LV ejection fraction quantification. This data set was analyzed with software that displayed cardiac images in short axis and 2- and 4-chamber views. The level of mitral annulus was manually defined. Automatic setting of signal intensity threshold and tracing of left ventricular endocardial borders was performed for each view. Each of the latter 2 steps was manually corrected if necessary. Automated volume calculations at each phase were performed and LV end-diastolic and end-systolic volumes and ejection fraction were displayed.

Myocardial perfusion imaging was performed using a 1-day rest-stress technetium-99-sestamibi protocol. Exercise stress studies were performed in 212 patients; pharmacologic stress with dipyridamole or adenosine in 78 patients, and dobutamine in 2 patients. A minimal dose of isotope (10 mCi) was injected for imaging at rest and 25 mCi was injected for stress imaging; higher doses were used as needed depending on patient weight. Gated single photon computed tomographic MPI was performed on the high-dose stress study, including assessment of LV ejection fraction, using either a PRISM 3000 triple-headed system (Picker International Inc., Cleveland, Ohio) with 120 images (3° intervals over 360° circular orbit at 46 s/step) or an ADAC Cardio 60 dual-headed system (Milpitas, California) with 64 images (3° interval over 180° at 25 s/step). A 64 × 64–image matrix and high-resolution collimators were used for both systems. Quantification of LV ejection fraction was performed using quantitative gated scintigraphy with a gating rate of 8 frames/s [8]. Quality control of quantitative measurements was performed by visually inspecting endocardial borders. When manual alterations were required, repeat calculations were made [9].

Obstructive coronary artery disease was diagnosed by coronary angiography if there was greater than 50% obstruction of at least 1 major coronary artery.

Student's *t* tests were used to analyze continuous variables. Chi-square tests were used to analyze dichotomous variables. Pearson's correlation coefficient was calculated.

A Bland-Altman plot (Figure 1) was constructed to compare LV ejection fraction measured using MPI with that measured using CTA. For each patient, plot differences in LV ejection fraction measurements were expressed as percentage of averages. The limits of agreement of the Bland-Altman plot were calculated with 95% confidence limits.

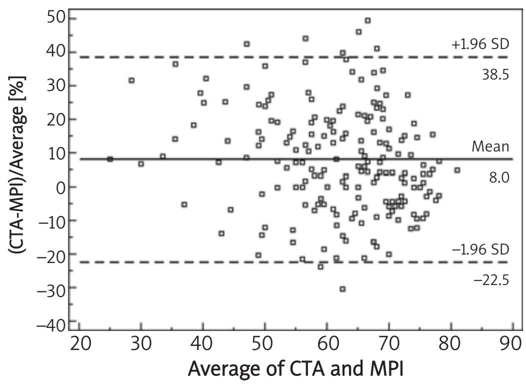

Figure 1. Shows a Bland-Altman plot assessing the agreement between the LV ejection fraction from CTA and MPI. Calculation of the Bland-Altman limits of agreement with a 95% confidence interval yielded a lower limit of minus 22.5% and an upper limit of 38.5%, with 12 of 292 patients (4%) outside the 2-SD limits

Table I. Baseline characteristics of patients and prevalence of obstructive coronary artery disease by coronary angiography in patients who had measurement of left ventricular ejection fraction by myocardial perfusion imaging versus coronary computed tomography angiography in 292 patients

Variable	Percent [%]
Men	61
Women	39
Age [years]	66 ±12
Prior coronary bypass surgery	15
Prior percutaneous coronary intervention	24
Obstructive coronary artery disease	76

Table II. Comparison of left ventricular (LV) ejection fraction by myocardial perfusion imaging (MPI) versus coronary computed tomography angiography (CTA) in 292 patients

	MPI	CTA	*p* value
Mean LV ejection fraction	61 ±12%	65 ±11%	< 0.001
LV ejection fraction ≥ 50%	250 (86%)	266 (91%)	< 0.05
LV ejection fraction 36-49%	31 (11%)	22 (8%)	NS
LV ejection fraction ≤ 35%	11 (4%)	4 (1%)	NS

Results

Table I shows the mean age and prevalence of men and of women, of prior coronary artery bypass surgery, of prior percutaneous coronary intervention, and of obstructive coronary artery disease diagnosed by coronary angiography after performance of the CTAs and MPIs. Table II shows the mean LV ejection fraction, the prevalence of an LV ejection fraction ≥ 50%, the prevalence of an LV ejection fraction of 36-49%, and the prevalence of an LV ejection fraction ≤ 35% by MPI versus CTA in 292 patients. Table I also lists levels of statistical significance. The Pearson's correlation coefficient for the plot of LV ejection fraction measured by MPI versus CTA was $R = 0.67$, $p < 0.001$.

Figure 1 shows a Bland-Altman plot assessing the agreement between the LV ejection fraction from CTA and MPI. Calculation of the Bland-Altman limits of agreement with a 95% confidence interval yielded a lower limit of minus 22.5% and an upper limit of 38.5%, with 12 of 292 patients (4%) outside the 2-SD limits.

Discussion

Left ventricle ejection fraction measured in 52 patients with heart failure by echocardiography, radionuclide ventriculography, and cardiovascular magnetic resonance showed that the results were not interchangeable [10]. In 49 patients with known or suspected coronary artery disease, measurement of LV ejection fraction by gated single photon emission computed tomography, 2-dimensional echocardiography, and CTA showed that the mean resting LV ejection fractions were 62, 55, and 58%, respectively [11].

In 52 patients with suspected coronary artery disease, the mean LV ejection fraction in the biplane view was 58% for 2-dimensional echocardiography versus 60% for CTA [12]. In 70 patients with suspected coronary artery disease, the mean LV ejection fraction was 2% higher in patients when measured by CTA than when measured by 2-dimensional echocardiography [13].

The results from the present study performed in 292 patients with known or suspected coronary artery disease with chest pain or dyspnea with an average of 18 days between the 2 tests showed that the resting LV ejection fraction was significantly higher when measured by CTA (65%) than when measured by MPI (61%) ($p < 0.001$). Of the 292 patients, the LV ejection fraction was normal in 250 patients (86%) when measured by MPI and was normal in 266 patients (91%) when measured by CTA ($p < 0.05$). The Pearson correlation coefficient between the 2 tests was $R = 0.67$, $p < 0.001$. The Bland-Altman plot showed that the agreement between the 2 tests was only moderate.

Heart rate at the time of study is an important confounder of the results of LV ejection fraction measurements in this study. Coronary computed tomography angiography was performed in the relatively bradycardic state, whereas MPI was performed in the tachycardic state, a side effect of the physiologic or pharmacologic stress needed for this test. Heart rate is an important determinant of LV ejection fraction measurement and probably explains the higher LV ejection fraction seen with CTA in our large study of 292 patients and in previous small studies [11-13].

These data clearly indicate in a large group of patients with known or suspected coronary artery disease in which measurements of LV ejection fraction by CTA and by MPI were performed an average of 18 days between the 2 tests that the LV ejection fraction is significantly higher when measured by CTA than when measured by MPI.

Left ventricle ejection fraction values are not interchangeable between different methods of measurement.

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All authors state that they have no conflicts of interest pertaining to this article.

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