Gated 99mTc-MIBI single-photon emission computed tomography for the evaluation of left ventricular ejection fraction: comparison with three-dimensional echocardiography

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Abstract

Objective Parameters of left ventricular systolic function directly influence the management of patients with suspected coronary artery disease (CAD). Quantitative gated single-photon emission computed tomodraphy (QGS; Cedars-Sinai Medical Center, Los Angeles, CA, USA) allows the computation of left ventricular ejection fraction (LVEF) from myocardial perfusion imaging studies which are frequently performed on patients with suspected CAD. Three-dimensional (3D) echocardiography is considered to be the echocardiographic “gold standard” for the quantification of LVEF. We sought to compare QGS with 3D echocardiography in the evaluation of EF in patients with suspected CAD.

Methods Ninety-one consecutive patients with suspected CAD, scheduled for coronary angiography, underwent rest electrocardiographic-gated technetium-99m methoxyisobutylisonitrile SPECT (G-SPECT) with measurement of LVEF by QGS and transthoracic 3D echocardiography with off-line measurement of LVEF (Tomtec 4D LV Analysis 1.1). The diagnosis of CAD was based on coronary angiography, performed on every patient.

Results Nine patients were excluded from the analysis owing to unsuitability for 3D echocardiography (8 patients) or G-SPECT (1 patient). In the remaining group of 82 patients, 71 (87%) had significant CAD, 34 (42%) had a history of myocardial infarction, and 50 (61%) had perfusion defects at rest G-SPECT images. The mean LVEF measured by QGS and 3D echocardiography was 53 ± 13% and 53 ± 10%, respectively. The mean difference in LVEF between 3D echocardiography and QGS was 0.1 ± 6.0% (P = 0.87), and the correlation between the values obtained by both methods was high (r = 0.88, P < 0.001). The largest discrepancies were observed in patients with small ventricular volumes.

Conclusions In patients undergoing diagnostic work-up for CAD, the measurement of LVEF by QGS algorithm provides high correlation and satisfactory agreement with the results of reference ultrasound method—3D echocardiography.

Keywords Left ventricular ejection fraction · Gated single-photon emission computed tomography · Three-dimensional echocardiography · Coronary artery disease

Introduction

The evaluation of left ventricular systolic function is the most common indication for noninvasive cardiac imaging. Parameters of systolic function directly influence the management of patients with various cardiovascular diseases. In clinical practice, this task is most commonly performed using two-dimensional (2D) echocardiography. Unlike 2D techniques, three-dimensional (3D) echocardiography does not rely on geometrical assumptions simplifying the shape of the analyzed cavity, and thus allows accurate quantification of left
ventricular ejection fraction (LVEF) even in patients with asymmetric, distorted ventricles [1–3]. However, in clinical practice, 3D echocardiographic quantification is not yet routinely performed.

Electrocardiographic (ECG)-gated single-photon emission computed tomography (G-SPECT), a well-established method of myocardial perfusion assessment, is frequently performed on patients with suspected coronary artery disease (CAD). Quantitative gated SPECT algorithm (QGS) allows the computation of LVEF on the basis of data acquired during perfusion studies [4–6]. However, concerns have been raised about the accuracy of such measurements in patients with large perfusion defects [7]. Furthermore, G-SPECT has been previously compared with 2D echocardiography [8–10], but not with echocardiographic “gold standard”—3D echocardiography. Therefore, we sought to investigate the agreement of G-SPECT and 3D echocardiography in quantification of LVEF in patients with suspected CAD scheduled for coronary angiography.

Materials and methods

Patient population

We prospectively studied 91 consecutive patients (60 men, 31 women) with suspected stable CAD scheduled for coronary angiography in our institution. Exclusion criteria included clinical instability, significant arrhythmia (including atrial fibrillation), and previous angiographic diagnosis of noncoronary myocardial disease.

Study protocol

Within 14 days preceding coronary angiography, all patients underwent ECG-gated technetium-99m-methoxyisobutylisonitrile ($^{99m}$Tc-MIBI) SPECT and 3D echocardiography. The results of G-SPECT did not influence the initial qualification for coronary angiography. The study protocol was approved by the Ethics Committee of our institution, and a written consent was obtained from all participants.

SPECT

A G-SPECT study (8 gates/cycle) was obtained at rest. Approximately 1 h following an injection of a weight-adjusted dose (555–1100 MBq) of $^{99m}$Tc-MIBI, 64 projections, each lasting 25 s, were acquired over a 180° arc, from the 45° right anterior oblique to the 45° left posterior position using a Varicam dual-head camera (GE Medical Systems, Milwaukee, WI, USA). Data were reconstructed with filtered backprojection (Butterworth filter order 2.5, cutoff frequency 0.36 of Nyquist frequency), using commercially available Xpert workstation (GE Medical Systems). Perfusion data were analyzed qualitatively and quantitatively (CEqual software, Cedars Sinai Medical Center, Los Angeles, CA, USA). Perfusion defects were assigned to territories of left anterior descending (LAD) coronary artery, left circumflex (LCx) coronary artery, and right coronary artery (RCA) on the basis of typical coronary distribution. LVEF was assessed with the commercially available automated software—QGS.

3D echocardiography

All patients underwent transthoracic 3D echocardiographic data acquisition (freehand scanning technique, Acuson Sequoia C256, Siemens Medical Solutions, Malvern, PA, USA) with off-line left ventricular reconstruction and LVEF measurement on the basis of semi-automated endocardial border detection in six apical planes (Tomtec 4D LV Analysis 1.1, Munich, Germany). Datasets of suboptimal quality precluding reliable measurement were excluded from further analysis.

Coronary angiography

Selective coronary angiography was performed using the Judkins or Sones technique. The angiograms were analyzed quantitatively by a single investigator blinded to all other data. Significant CAD was defined using a cut-off value of ≥50% luminal diameter stenosis of one or more major coronary arteries or their major branches.

Statistical analysis

Continuous and categorical variables are expressed as mean ± SD and percentages (%), respectively. Comparisons between LVEF values measured by 3D echocardiography and QGS were performed using Student’s paired t test and Bland and Altman’s plot. Correlation between measurements was assessed by linear regression analysis (Pearson’s r).

Results

One (1%) patient could not undergo G-SPECT study owing to a broken arm resulting in an inability to adopt the required position. Suboptimal image quality precluded reliable 3D echocardiographic examination in