Diastolic left ventricular functional indices: Comparison between gated myocardial perfusion SPECT and echocardiography

Original Article

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ABSTRACT

Introduction: Many patients have only diastolic dysfunction without any abnormality in systolic function. We compared cardiac diastolic parameters obtained by gated myocardial perfusion SPECT (Gated SPECT) with those evaluated by echocardiography.

Methods: Forty-nine patients (aged 37-85 years, 19 males and 30 women) underwent Gated SPECT and echocardiography. Gated SPECT images were obtained with 16 frame/cardiac cycles. We derived the following diastolic indices: peak filling rate (PFR), time to PFR (TTPFR), mean filling rate in the first 1/3 of the diastole (MFR/3) and second filling rate (PFR2) due to left atrial contraction. In echocardiography we obtained the indices of ventricular filling: E wave, A wave, the E/A ratio, and the E wave deceleration time (DT) were considered. The LV isovolumic relaxation time (IVRT) was also determined.

Results: There was no significant correlation between echocardiographic findings and diastolic gated SPECT findings. Using Post-Hoc One-way analysis significant difference was seen only in MFR/3 between diastolic dysfunction groups (P value=0.02). There was no significant difference in other diastolic gated SPECT variables in these groups.

Conclusion: Diastolic parameters obtained from 16-frame/cardiac cycle gated SPECT didn't correlate with echocardiographic indices.

Key words: Gated SPECT; Echocardiography; Diastolic function; Peak filling rate

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INTRODUCTION

In heart failure, in addition to decrease in systolic function, impaired diastolic function also can be a contributing factor. About 40-50% of patients with heart failure have only diastolic heart failure while left ventricular (LV) systolic function must be preserved [1]. Cardiac catheterization, first pass & equilibrium radionuclide ventriculography and Doppler echocardiography are used for the assessment of LV systolic and diastolic function [2-5].

Gated myocardial perfusion single-photon emission computed tomography (Gated SPECT) enables simultaneous assessment of myocardial perfusion and LV systolic & diastolic function [2, 6, 7].Gated SPECT studies are regularly performed for diagnosis and risk assessment of coronary artery disease [1, 8]. Gated SPECT provides useful information about LV functional indices [1].

Because of echocardiography is routinely used for determination of systolic and diastolic LV function, the aim of this study was to assess LV diastolic functional indices using Gated SPECT in comparison with Doppler echocardiography. We compared cardiac diastolic parameters obtained by Quantitative Gated SPECT (QGS) with those obtained by echocardiography. In addition to M-mode, two dimensional echocardiography, we used pulse-wave Doppler examinations as well as Tissue Doppler Imaging (TDI) for detailed and quantitative assessment of diastolic function of the left ventricle.

METHODS

Study population

Forty-nine patients (aged 37-85 years, 19 males and 30 women) were studied. They underwent electrocardiographic (ECG)-gated myocardial perfusion SPECT (Gated SPECT) as well as echocardiography. The study was approved by the ethics committees of our institution, written informed consent was obtained from all patients.

Gated technetium-99m MIBI myocardial perfusion SPECT

A dose of 740 MBq of ^{99m}Tc-MIBI was administered under the resting condition. 90 min later, rest gated SPECT images were obtained in the supine position with a variable angle, Dual-head rotating gamma camera in the 90°-setting (Dual Head Variable-Angle E.CAM; Siemens) equipped with high-resolution, low-energy collimators. From RAO 45˚ to LPO 45˚, thirty two views over an 180˚ orbit were obtained in a step-and shoot format (25 seconds per view and 16 frames per cardiac cycle with a 20% acceptance window). Energy window centered at 140 ±20 keV. The zoom factor was1.46 and the images were stored in a 64×64 matrix in the computer.

Reconstruction was performed by filtered back projection using a Butterworth filter (cut-off value was 0.35 cycle/cm for gated data and 0.55 cycle/cm for ungated data, order =5) without attenuation correction [9, 10].

Using QGS (quantitative gated SPECT) software, the LV volume curves were obtained and from this volume curves, we derived the following diastolic indices: peak filling rate (PFR), time to PFR (TTPFR), mean filling rate in the first 1/3 of the diastole (MFR/3) and second filling rate (PFR2) due to left atrial contraction.

Echocardiography

All patients underwent transthoracic echocardiography. An independent Echo cardiologist blinded for Gated SPECT results performed M-mode, two dimensional, and pulse-wave Doppler examinations as well as Tissue Doppler Imaging (TDI).

Patients in the left lateral decubitus position underwent echocardiography using a Vivid 3,GE system with 2.5-3.5 MHTZ probe according to the last ASE/AHA guidelines. Conventional parasternal long- and short-axis standard views as well as two and four- chamber apical views were obtained [9]. Quantitative assessment of LV dimensions was obtained using M-mode images from the parasternal long-axis views. The following parameters were measured in Doppler studies: indices of ventricular filling derived from the mitral valve flow velocity at early phase (E wave) as well as at the maximal late flow (A wave), the E/A ratio, and the E wave deceleration time (DT). The LV isovolumic relaxation time (IVRT) was determined.

Based on guidelines of American Society of Echocardiography, grade of diastolic dysfunction was determined in each patient.

Statistical analysis

Data are expressed as mean ± sd. Two-tailed Student's paired sample t test was used to compare continuous variables and we compared diastolic indices using Pearson's correlation coefficient (r). Differences were considered statistically significant at P value< 0.05. The calculations were performed using SPSS 24.

RESULTS

Table 1 showed variables derived from the gated SPECT and echocardiography. There was no significant correlation between echocardiographic findings (such as E/A ratio) and diastolic gated SPECT findings.

Patients were grouped based on diastolic function: normal, mild, moderate and severe diastolic dysfunction.

Table 1: Diastolic left ventricular functional indices in gated myocardial perfusion SPECT and echocardiography.

Variable	Minimum	Maximum	Mean	Standard Deviation
E	34	120	61.63	19.11
A	46	128	82.93	18.28
DT	120	293	218.67	39.31
IVRT (msec)	60	144	94.24	17.62
E/A	0.38	1.5	0.77	0.29
RPFR (EDV/S)	0.28	5.44	2.72	1.13
RPFR/2(EDV/S)	0.00	2.86	1.15	0.97
RMFR/3 (EDV/S)	0.11	2.31	1.40	0.54
RTTPF (msec)	33	281	156.74	44.92

Using Post-Hoc One-way analysis significant difference was seen only in MFR/3 between diastolic dysfunction groups (Table 2; P value=0.02). There was no significant difference in other diastolic gated SPECT variables in these groups.

Table 2: Diastolic dysfunction (DD) grades in echocardiography and mean filling rate in the first 1/3 of diastole (MFR/3).

Diastolic Function	MFR/3
Normal	1.50
Mild DD	1.44
Moderate DD	1.41
Severe DD	1.38

DISCUSSION

Previously, many studies reported significant correlation between systolic gated SPECT findings and systolic echocardiographic indices [11].

In diastolic function, LV relaxation is an important index. PFR has been used as a major diastolic functional parameter. Myocardial relaxation has both active and passive processes [1, 12]. Therefore, filling rate during first third of diastole is an important index of early diastolic performance [1].

In our study, we didn't find significant correlation between diastolic gated SPECT findings and echocardiography while Yamano et al. and a few other studies found correlation between PFR in gated SPECT and the peak velocity of the E wave [2, 13, 14]. But they didn't find correlation between PFR and DT and IVRT. We only found significant difference between diastolic dysfunction groups in MFR/3. In our study, 16 frames per cardiac cycle was used for data acquisition in gated SPECT while Yamano et al, 32 frames per cardiac cycle was used for acquisition [2]. Nakae et al reported positive correlation between the E/A ratio and PFR using 16 frame per cardiac cycle [1].

Several studies reported that diastolic LV functional indices obtained from QGS with 16 frames tended to be underestimated as compared with 32 frames/cardiac cycle [1, 15].

Nakajima et al. suggested that diastolic LV functional parameters obtained by gated SPECT is clinically useful if more than a 16-frame/cardiac cycle was used [15].

Therefore, the diastolic indices from gated SPET may require different interpretation as compared to the Doppler echocardiography.

Study limitations

Besides the acquisition using the 16 frames per cardiac cycle instead of 32 frames, small sample of patients may be one limitation of our study. In addition the aim of the study was only comparison between routinely used echocardiography and gated myocardial perfusion SPECT. It is recommended to perform a study using a gold standard to determine the accuracy of the diastolic indices in gated SPECT as well as in the echocardiography.

In future, it is recommended to study a large population for evaluation of the effectiveness of diastolic parameters in gated SPECT specially on serial gated SPECT imaging and comparison the serial indices derived from the gated SPECT. The diastolic gated SPECT findings may be useful if obtained in serial gated SPECT images. In contrary with systolic findings, diastolic gated SPECT indices may not be useful for comparison with previous or future diastolic echocardiographic findings.

CONCLUSION

Although gated SPECT is useful for evaluation of myocardial perfusion, and LV systolic function (with excellent correlation with other imaging modalities), diastolic parameters obtained from 16-frame/cardiac cycle gated SPECT may not correlate well with echocardiographic indices.

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