ORIGINAL ARTICLE

Contractility evaluation by 2 dimensional echocardiography and gated SPECT myocardial perfusion scintigraphy in hypertensive patients with clinical presentation of atypical chest pain

Yalçin H[1], Karayalçin B[2], Boz A[2], Talay B[2], Belgi A[3], Yalçin F[4]

[1]Mustafa Kemal University, School of Medicine, Department of Nuclear Medicine, Antioch, TURKEY
[2]Akdeniz University, School of Medicine, Department of Nuclear Medicine, Antalya, TURKEY
[3] Akdeniz University, School of Medicine, Department of Cardiology, Antalya, TURKEY
[4] Mustafa Kemal University, School of Medicine, Department of Cardiology, Antioch, TURKEY

Abstract

Background: Hypertension (HT) is a growing health problem in the population and associated with increased cardiovascular event risk and mortality. In hypertensive patients, progressive left ventricular (LV) contractility deterioration is detectable by gated single photon emission computed tomography (SPECT) myocardial perfusion scintigraphy[9]. We planned this study to explore the agreement in ejection fraction (EF) determination between 2 dimensional echocardiography and gated SPECT analysis in selected group of patients with hypertension.

Patients and Methods: We studied 26 consecutive patients (mean age 56.5 ± 8.8 years; 6 men) with hypertension. Quantitative contractility analysis by both echocardiography and SPECT at rest was performed to investigate the agreement between two diagnostic tests.

Results: EF at rest was greater than 55 % in all patients. All patients had a clinical presentation of atypical chest pain. Therefore, in addition to quantitative contractility analysis at rest by echocardiography and myocardial SPECT perfusion scintigraphy, we examined ischemia by stress induction and determined that 10 patients had ischemic finding (38.4 %). The mean value of EF calculated by echocardiography was 67.5 ± 5.7 %, while EF by gated SPECT was 72.8 ± 8.5 %. We documented an acceptable agreement in EF determination between these 2 diagnostic tests by meaningful correlation ($r = 0.556$, $p = 0.003$). There was no regional contractility deterioration despite existence of ischemia in 10 patients of the study group.

Conclusions: We observed that both echocardiography and gated SPECT can be used for quantification of EF in the hypertensive patients with an acceptable agreement. Hippokratia 2011; 15 (1): 64-68

Key Words: hypertension, 99mTc-MIBI myocardial gated SPECT, echocardiograhy

Corresponding author: Hulya Yalçin Department of Nuclear Medicine, Mustafa Kemal University School of Medicine, 31100 Antioch, TURKEY, Phone: 90 (326) 229- 1000, Fax: 90 (326) 214- 4977, email: hulyapeker@yahoo.com

Hypertension (HT) is a growing health problem in the population and associated with increased cardiovascular event risk and mortality. HT is the main model of the pressure overload and enhances the risk for heart failure in the population[1] HT induces myocyte hypertrophy depending on the increase in afterload and leads to myocardial fibrosis due to increased collagen synthesis[2] Progressive course of hypertensive heart disease contributes to hypertension-mediated left ventricular (LV) remodeling and ultimately results in LV dilation[3]. Twenty seven percent of men and 36 % of women are determined as hypertensive in the Turkish population[4].

HT has been reported to lead to the development of heart failure in 39 % of males and 59% of females, and there is a history of HT in approximately 90% of the patients with heart failure[5]. Recently, we have mentioned that LV cavity geometry and function can be evaluated by a variety of diagnostic methodologies, among which some are advantageous and disadvantageous[6]. It was pointed out previously that LV geometric distortion and regional LV cavity irregularity are the major errors of LV volume calculations leading to limitation of diagnostic methodologies[7]. We previously reported that heart in elderly itself is associated with a time-dependent LV contractility deterioration[8]. In hypertensive patients, progressive LV contractility deterioration is detectable by gated single photon emission computed tomography (SPECT) myocardial perfusion scintigraphy[9].

Ejection fraction (EF) as an index of LV contractility is widely used due to its relative ease of measurement with various of imaging technics[10]. We planned this study to explore the agreement in EF determination between 2 dimensional echocardiography and gated SPECT analysis in hypertensive patients.

Materials and Methods

The present study was performed at the Cardiology Departments of Akdeniz and Mustafa Kemal Universities in Turkey. All echocardiographic exams were performed using echocardiographic machine (VIVID 7, General Electric, Horten, Norway, equipped with a matrix-array probe M3S) following a standardized echocardiographic protocol allowing reproducible assessment of LV structure and function[7]. Systolic and diastolic LV volumes were measured using modified Simpson method from the apical four-chamber view[11]. End-diastole was accepted as the onset of the q wave of the simultaneous ECG.

Mobile and active patients with normal functional capacity on antihypertensive medications with undercontrolled blood pressure levels as less than 140 / 90 mmHg and clinical presentation of atypical chest pain, who were followed-up by out patient clinics at the cardiology departments were included in the study. All the patients had normal ECG findings and a normal cardiothoracic ratio. Patients with previous ischemia or myocardial infarction history, diffuse or segmenter wall motion abnormality, valvular heart disease, previous cardiac surgery, a clinical diagnosis of chronic lung or musculoskeletal disease were excluded. None of our patients had evidence of LV hypertrophy on the rest ECG or a family history of heart disease including hypertrophic cardiomyopathy. Measurements were performed as described previously to calculate LV mass[12].

All patients underwent 99mTc-MIBI gated myocardial perfusion SPECT with the two day protocol. As stress modality, treadmill exercise test with Bruce protocol[13] was used. Exercises were consisted of a treadmill stress test with Bruce protocol. The criteria to terminate the study were achievement of at least 85 % age-predicted heart rate, severe chest pain, significant ECG changes (ST depression ≥ 2 mm), development of significant arrhythmia, or blood pressure changes (hypertension, diastolic blood pressure ≥ 120 mmHg or systolic blood pressure ≥ 240 mmHg; hypotension, decrease in systolic blood pressure ≥30 mmHg compared to basal value). At peak exercise, 555 to 740 MBq (15–20 mCi) Tc-99m MIBI was injected and patients were asked to continue exercise for a period of up to 1.5min. Myocardial perfusion SPECT imaging was begun 45 min after the injection of 555 to 740 MBq (15–20 mCi) Tc-99m MIBI at stress and the rest images were acquired one day later after the injection of 555 to 740 MBq (15–20 mCi) Tc-99m-MIBI. Gated SPECT studies were acquired with a dual-head gamma camera (Sopha DST.XL.i France) equipped with a low energy all purpose collimator and the energy was centered on 140

Table 1: Demographic, clinical and laboratory features of the patients.

	Patients (n=26)
Age (year)	56.5 ± 8.8
Male/female (number)	6/20
Smoking (number)	4
Hyperlipidemia (number)	17
Obesite(number)	10
Echocardiography EF	67.5 ± 5.7
Gated SPECT EF	72.8 ± 8.51
LV interventricular septum thickness (centimeter)	10.7± 1.3
LV posterior wall (centimeter)	10.2± 1.5
LV mass male (gram)	222.7± 73.2
LV mass female (gram)	212.1± 45.2

Data are mean ± SD

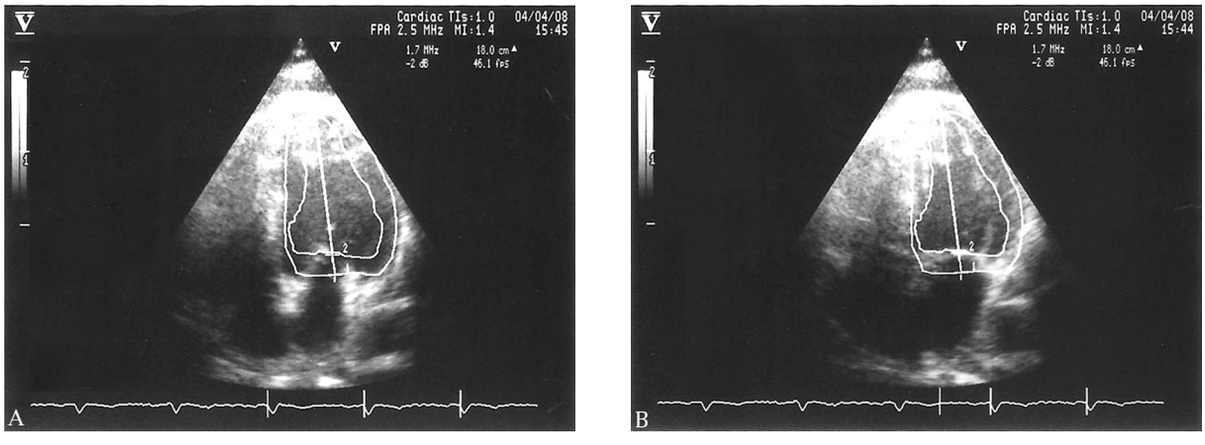

Figure 1A and 1B: ED and ES volume traces demonstrate both apicobasal (ED lower MA level on the fig. 1a and ES upper MA level on the fig. 1b) and radial (inner cavity border of ES trace) LV contractility on the 4 chamber apical 2 dimensional echocardiographic view of a hypertensive patient with EF of 61%.
(ED: enddiastolic, ES: endsystolic, MA: mitral annulus, LV: left ventricle, EF: ejection fraction).

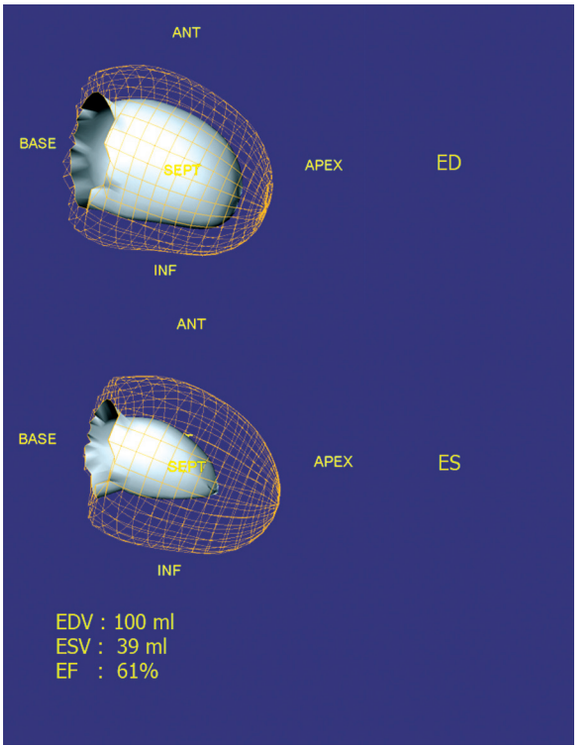

Figure 2: ED and ES images of the same hypertensive patient.
(ED: enddiastolic, ES: endsystolic, EDV: enddiastolic volume, ESV: endsystolic volume, EF: ejection fraction).

keV with a 20% window. Images were acquired using a step and-shoot circular orbit starting from the 45° right anterior oblique to the 135° left posterior oblique projection. Thirty-two projections were obtained using a 64 X 64 matrix for 25 sec per frame. Tomographic images were reconstructed using a ramp filter with a Butterworth filter (order, 8; cutoff frequency, 0.34 cycle/cm for gated study and 0.47 cycle/cm for nongated study). The software programs used for quantitative analysis were Emory Cardiac Tools Box (version 3.5.7.13).

The study project was approved and ethic consent was taken from the Institutional Ethic Comitee. Data were evaluated with SPSS statistical software (SPSS, Inc., Chicago, IL, USA). Measurement results are presented as mean and standard deviation.Distribution of normality was tested using One-Sample Kolmogorov-Smirnov test, both variables were found to be distributed normally. Data comparison of both groups was made by Pearson correlation test. The level of $p< 0.05$ was considered statistically meaningful. Also a scatter dot graphic was drawn using SPSS statistical software.

Results

We evaluated total 26 hypertensive patients who were followed-up by out patient clinics at tertiary university center located on the southern part of the country. They are all mobile and active individuals with normal functional capacity and were on antihypertensive medications with undercontrolled blood pressure levels as less than 140 / 90 mmHg. 23.1 % were males, 76.9 % were females, and the mean age was 56.5± 8.8 years. Four of our patients (15.4 %) were cigarette smokers. Demographic characteristics of patients with hypertension in the study are shown in Table 1.

LV interventricular septum and posterior walls thickness lied within normal limits as 10.7± 1.3 cm and 10.2± 1.5 cm, respectively. LV mass was 222.7± 73.2 gr in men and 212.1± 45.2 gr in women demonstrating that mean LV myocardial mass also was in normal limits and no LV hypertrophy. Since all patients in the current study had clinical presentation of atypical chest pain, in addition to quantitative contractility analysis at rest by echocardiography and myocardial SPECT perfusion scintigraphy we also examined ischemia by stress induction and determined that 10 patients had ischemic finding (38.5 %). Quantitative contractility analysis by both echocardiography and SPECT at rest to investigate the agreement between two diagnostic tests was performed and showed that there was no contractility deterioration and despite ischemia presence in 10 patients of the study group with hypertension.

EF at rest was greater than 55 % in all patients. The mean value of EF on echocardiography using modified Simpson method (Figure 1a, 1b) was 67.5± 5.7 %, while EF by gated SPECT was 72.8± 8.5 % (Figure 2). The correlation between EF values of two diagnostic tests was meaningful ($r = 0.556$, $p = 0.003$, Figure 3).

Discussion

Clinical presentation of hypertension may be associated with atypical chest pain. In the current study, all consecutive hypertensive patients in the outpatient clinic had atypical chest pain complaint. In patients with chest pain, wall motion analysis has shown LV hypercontractility[14]. In this study, hypertension was more frequent in patients with hypercontractile response than the others without

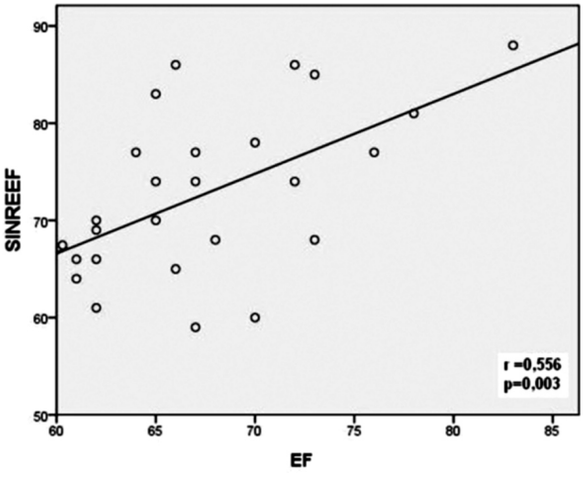

Figure 3: The correlation between EF values determined by 2 dimensional echocardiography and gated SPECT analysis.

hypercontractility. Microneurography and isotope dilution methodology to comprehensively study sympathetic activity in hypertensive patients has shown that increased sympathetic activity largely confined to the heart and its trophic effects are directly related to the effect of hypertension on myocardium[15] Hypercontractility is possibly a part of the clinical spectrum in early stage hypertension[16]. We detected increased myocardial tissue velocities in hypertensive patients with basal septal hypertrophy under pharmacologic stress[17] We also reported that stress-mediated hypercontractility may have regional features and may be more striking on the LV base[18].

In the present study, hypertensives were partly associated with ischemia. Ischemia prevalence was 38.5 % of the hypertensive patients in our group. Ischemia has been reported as an important contributor to progression of hypertensive heart disease[3] In the process of hypertensive heart disease, myocardial structural impairement due to apoptosis and fibrosis lead to hypertensive LV remodeling and a decrease in LV contractility[2]. In the progressive course of the disease, LV hypocontractility developes and is associated with adverse cardiovascular risk[19] Bigi et al. in their larger study group of 415 hypertensive patients consistently reported that 37 % of the hypertensive study group had ischemic finding on SPECT[9]. In the current study, additional evaluation of quantitative contractility by both echocardiography and SPECT to examine the agreement between two diagnostic tests was performed. We found an acceptable agreement between echocardiography and gated SPECT in EF determination in hypertensive patients. It has been suggested that difference in quantitative EF determination may be related to diversity of studied populations[20]. In the current study, we evaluated LV contractility by quantitative EF determination using both diagnostic tests in patients on antihypertensive medications and clinical presentation of atypical chest pain.

In our recently presented study from the same region, we have found the prevalence of hypertension in patients with heart failure as 40.8 %[21]. This percentage which is even lower than the previous studies[22]. Shows that a considerable percentage of heart failure patients have hypertension history a fact which emphasises the importance of LV contractility evaluation in hypertensive patients. We previously found the preserved LV function in well-treated hypertensive patients using comprehensive mitral annular reconstruction methodology with real-time 3 dimensional echocardiography[23]. Recently, an acceptable myocardial metabolism has been documented in LV hypertrophy stage which is a consistent finding in LV hypertrophy patients with preserved LV function, prior to development of heart failure[24].

Preserved LV function may be the reflection of efficient antihypertensive medication and precise evaluation of LV contractility in patients with hypertensive heart disease is crucial to early diagnose heart failure development. It has been a great challenge to block this progressive process and prevent heart failure by number of antihypertensive medications[22]. As a conclusion, we detected that both 2 dimensional echocardiography and gated SPECT can be used for quantification of EF with an acceptable agreement in patients with hypertension.

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