

Effect of imaging time on post stress left ventricular ejection fraction and volume measures by gated myocardial perfusion single photon emission computed tomography

Görüntüleme zamanının gated miyokard perfüzyon tek foton emisyon bilgisayarlı tomografisi ile ölçülen sol ventrikül ejeksiyon fraksiyonu ve hacimleri üzerine etkisi

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ÖZET

Amaç: Efor sonrası sol ventrikül ejeksiyon fraksiyonu (LVEF) ve sol ventrikül volüm değerlerinin koroner arter hastalığı bulunan hastalardaki kardiyak ölüm tahmininde katkısı vardır. Bu çalışmada, efor sonrası görüntüleme zamanının Quantitative Gated SPECT (QGS-Cedars-Sinai) programı ile hesaplanan efor sonrası LVEF, end-diastolik volüm (EDV) ve end-sistolik volüm (ESV) üzerine etkisini araştırmayı amaçladık.

Hastalar ve yöntem: Bu çalışma 2008 ve 2009 yıllarında Elazığ Eğitim ve Araştırma Hastanesi Nükleer Tıp Birimine göğüs ağrısı nedeniyle Kardiyoloji Kliniğinden gönderilen 36 hasta üzerinde yapıldı. Tüm hastalara efor esnasında yapılan 99mTc-Mibi enjeksiyonunu takiben 20. ve 40. dakikalarda EKG-gated (8-bin frame modunda) miyokard perfüzyon SPECT sintigrafisi uygulandı. Kardiyak kantifikasyon yazılımı olan QGS programı kullanılarak LVEF, EDV ve ESV hesaplandı. İlk ve ikinci görüntülemelerden elde edilen LVEF, EDV ve ESV değerleri istatistiksel olarak birbirleri ile karşılaştırıldı.

Bulgular: İlk ve ikinci görüntülemelerden elde edilen LVEF, EDV ve ESV değerleri arasında istatistiksel olarak anlamlı farklılık bulunmadı ($p>0.05$).

Sonuç: Efor sonrası sol ventrikül fonksiyon parametreleri koroner arter hastalığı bulunan hastalardaki prognoz değerlendirilmesinde önemlidir. Efor bitiminden 20-40 dakika sonra yapılan miyokard perfüzyon SPECT sintigrafisi efor sonrası LVEF, EDV ve ESV değerleri açısından tekrarlanabilir değerler vermektedir. *Klin Den Ar Derg 2010; 1(3): 177-181*

Anahtar kelimeler: Kardiyak gated SPECT, sol ventrikül fonksiyonu, görüntüleme, QGS

ABSTRACT

Objectives: Post-stress left ventricular ejection fraction (LVEF) and LV volumes have incremental value in predicting cardiac death (CD) in patients with coronary artery disease. In this study, we aimed to investigate the effect of imaging time after exercise on post-stress LVEF, end-diastolic volume (EDV) and end-systolic volume (ESV) calculated by cardiac quantification software program called Quantitative Gated SPECT (QGS-Cedars-Sinai).

Materials and methods: This study was consisted of 36 patient referred to Nuclear Medicine Department from Cardiology Clinics because of chest pain in 'Elazığ Research and Training Hospital' in 2008-2009. In all patients, ECG Gated (8-bin frame mode) myocardial perfusion SPECT scintigraphy was performed 20 and 40 min later following 99mTc-Mibi injection during exercise. By means of the cardiac quantification software program called Quantitative Gated SPECT (QGS-Cedars-Sinai); LVEF, EDV and ESV were calculated. LVEF, EDV and ESV values obtained from initial and second acquisition were compared statistically.

Results: There was no statistically significant difference between post-stress LVEF, EDV and ESV measures of initial and second acquisition ($p>0.05$).

Conclusion: Left ventricular functional parameters after exercise are important for assess prognosis in patients with CAD. Post-stress LVEF, EDV and ESV measured on gated myocardial perfusion SPECT images within 20-40 min after completion of exercise give reproducible information. *J Clin Exp Invest 2010; 1(3): 177-181*

Key words: Cardiac gated SPECT, left ventricular function, imaging, QGS

INTRODUCTION

ECG-gated myocardial perfusion single photon emission computed tomography (SPECT) is widely used in evaluation of myocardial ischemia, infarct, assessment of myocardial viability and risk stratification for patients with coronary artery disease. Gated myocardial perfusion SPECT (MPS) also provide information about left ventricular functional parameters such as wall motion, left ventricular ejection fraction (LVEF), end-diastolic volume (EDV) and end-systolic volume (ESV).^{1,2} (Figure 1). Cardiac magnetic resonance imaging (MR) is considered reference method for LV functional parameters. In many studies in which measures of functional parameters by MR and gated myocardial perfusion SPECT were compared have shown good concordance of these two methods.³⁻⁵

In many studies it has been shown that post-stress LVEF and LV volumes have incremental value in predicting cardiac death (CD).⁶ Cardiac death rate was a function of the extent and severity of perfusion defects at stress on MPS (7). However, further risk stratification by LVEF demonstrated mortality rate increases as post-stress LVEF decreases.⁶ It has been also shown that left ventricular EDV and ESV were highly significant predictors of CD.^{6,8}

In guidelines, it has been advocated that the post-stress MPS imaging should begin 15-60 min after ^{99m}Tc-MIBI injection during exercise.^{9,10} In several studies, it has been reported that after completion of the stress, ischemic LV dysfunction may have persisted for a time period ranged from immediate to 30 min.^{8,13} In most centers, post-stress imaging procedure is initiated at the time point between 20 to 60 minute after ^{99m}Tc-MIBI injection. In this study we aimed to investigate that whether the time of 20 and 40 minute to start imaging after ^{99m}Tc-MIBI injection affect post-stress LVEF, EDV and ESV measures using ECG-gated myocardial perfusion SPECT.

MATERIALS AND METHODS

Thirty six patients (16 male, 20 female and mean age: 54 ± 13 years) who were referred from Cardiology Clinics to Nuclear Medicine Department for known or suspected coronary artery disease in Elazığ Training and Research Hospital in 2008-2009 were included in this study. ECG-gated myocardial

perfusion SPECT scintigraphy was performed 20 min later following ^{99m}Tc-MIBI injection during peak physiological exercise on treadmill. Bruce or Modified Bruce protocol was used.

Following initial acquisition was completed; patients were instructed to relax for a while, then repositioned on the patient table and reimaged by the same acquisition procedure about 40 minute later following ^{99m}Tc-MIBI injection. Double headed 'GE-infinia gamma camera' (GE Medical Systems, Milwaukee, WI, USA) equipped with a low-energy high-resolution collimator was used for imaging. 60 images at 30 projections, 25 sec per projection, were acquired over 180o (45o right anterior oblique to 135o left posterior oblique) on a 64 x 64 matrix. ECG-gating was acquired in 8 frames per cardiac cycle and attenuation or scatter correction was not performed. By means of cardiac quantification software called QGS (Cedars-Sinai Los Angeles, CA, USA; version 3.0) post-stress LVEF, EDV and ESV were calculated on two raw data of initial and second imaging for each patient. Filtered back-projection (FBP) reconstruction was performed with a low pass Butterworth filter (cut-off 0.52; power 5.0) and pixel size of 6.43 mm.

Statistical analysis was performed using the SPSS 15.0 software program (SPSS Inc., Chicago, Illinois, USA). Measures of LVEF, EDV and ESV values obtained from first and second acquisition were compared statistically with the paired Student's t-test and the Wilcoxon signed ranks test. P value of less than 0.05 was considered as statistically significant.

RESULTS

On MPS images, all patients had reversible perfusion defects at various degrees. Left ventricular functional parameters of all patients were shown on Table 1. In statistical analyses, there was not statistically significant difference between post-stress LVEF, EDV and ESV values obtained from QGS software ($p>0.05$) (Figure 2). There was also not significant difference between LV volumetric parameters of male and female patients ($p>0.05$).

Table 1. Post-stress LVEF, EDV and ESV measures of 36 patients obtained from QGS software, Mean±SD (range)

	1st acquisition	2nd acquisition
LVEF (%)	71.7 ± 7.9 (43-85)	70.1 ± 8.3 (43-82)
Male	68.1 ± 4.7 (61-79)	68.8 ± 6.9 (59-81)
Female	74.6 ± 8.8 (43-85)	71.3 ± 9.3 (43-82)
EDV (ml)	97.7 ± 20.8 (60-147)	97.9 ± 20.2 (62-151)
Male	94.9 ± 19.7 (60-128)	99.4 ± 21.7 (62-151)
Female	99.9 ± 21.8 (60-147)	96.7 ± 19.4 (62-132)
ESV (ml)	28.4 ± 12.9 (11-84)	30 ± 12.8 (12-78)
Male	30.6 ± 8.9 (13-49)	30.8 ± 14.6 (12-51)
Female	26.6 ± 15.4 (11-84)	28.9 ± 14.6 (12-78)

LVEF: left ventricular ejection fraction, EDV: end-diastolic volume
 ESV: end-systolic volume

DISCUSSION

It was shown that post-stress LVEF and LV volumes calculated by gated myocardial perfusion SPECT provide incremental data over perfusion and clinical information in the prediction of CD as well as the combined endpoint of CD or myocardial infarction.^{6, 8,12,13} Post-stress LVEF and CD rate are in relation exponentially, with a progressive increase in mortality as LVEF falls below 50%.^{6,12} It has been concluded that the amount of ischemia detected on MPS was the best predictor of nonfatal MI, and the post-stress LVEF measured by gated myocardial perfusion SPECT was the best predictor of CD.⁶

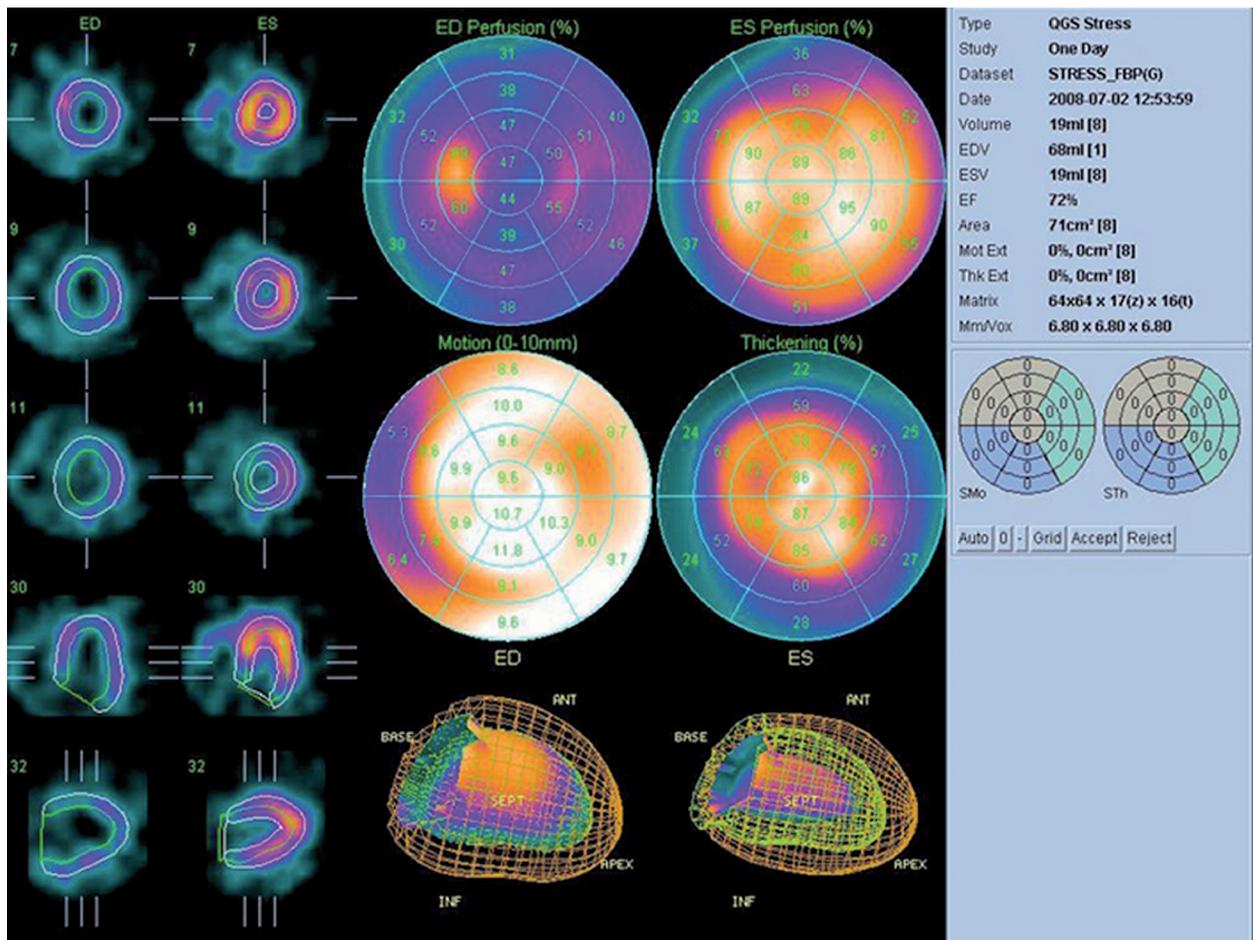


Figure 1. Cardiac quantification data of 39 year old male with normal myocardial perfusion on myocardial perfusion scintigraphy is seen above.

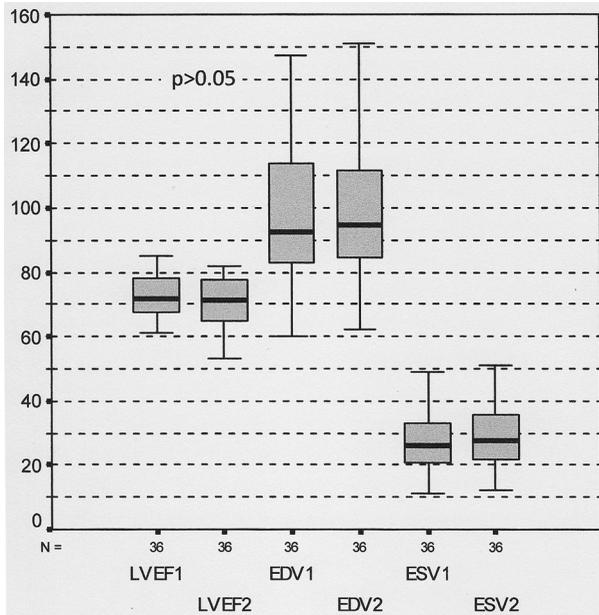


Figure 2. Post-stress LVEF, EDV and ESV of first and second acquisition

Lynne et al.¹¹ have designed a study to investigate whether LVEF calculated from post-stress SPECT reflects the basal value for LVEF or post-stress LVEF is reduced in some patients with stress-induced ischemia. In patients with reversible perfusion defects, post-stress LVEF was >5% lower than that at rest, whereas in the patients with normal myocardial perfusion or fixed perfusion defect post-stress LVEF was either $\pm 5\%$ greater than that at rest. They have concluded that post-ischemic stunning could affect post-stress LVEF. Age, gender, previous MI, tracer used and type of stress don't cause differences between LVEF at post-stress and resting period.^{11,14} However, in some studies it has been suggested that the post-stress LVEF is significantly lower than the LVEF at rest in patients with ischemia or without ischemia.¹⁵

In some studies using gated blood pool imaging, ischemic LV dysfunction manifested by global reduction of LVEF resolves rapidly after exercise. Those studies were performed during and immediately following upright or semi supine bicycle exercise in patients with CAD. It was found that LVEF rises during the early phases of exercise, then falls at the ischemia threshold and rises again immediately after stress.^{11,16-18} Whereas the other studies using serial gated blood pool imaging combined with echocardiography in patients with angiographically

proven CAD indicated that LV dysfunction may persist up to 2 hours after completion of exercise.^{11,19-21}

In our study, we acquired images at 20 and 40 min after completion of exercise. Acquisition lasted about 13 min. All patients in our study had reversible perfusion defects. We didn't find statistical differences between post-stress LVEF and LV volume measures at 20th and 40th min acquisition ($p > 0.05$). Data from male or female patients gave similar results ($p > 0.05$). These findings have shown that acquisition within 20-40 min time interval after exercise completion is suitable to measure post-stress LVEF and LV volumes, and imaging within 20-40 min at post-stress period doesn't reveal different results.

In conclusion, our findings have shown that the gated myocardial perfusion SPECT imaging after 99mTc-MIBI injection during exercise within 20-40 min give reproducible measures of post-stress LVEF and LV volumes.

Disclosure

The authors declare that they have no financial relationship with any organization related to the research and no conflict of interest.

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