Original Article

Gated myocardial perfusion SPECT in patients with left bundle block but having low probability of coronary artery disease; as compared to the patients with normal electrocardiogram

Seyed Hashem Danesh-Sani[1], Seyed Rasoul Zakavi[2], Ramin Sadeghi[2], Mansoure Fatemi[1], Maryam Torabian-Kakhki[3], Vahid-Reza Dabbagh kakhki[2]

[1]Department of Cardiovascular Diseases, Imam Reza Hospital, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
[2]Nuclear Medicine Research Center, Ghaem Hospital, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
[3]Faculty of Veterinary Medicine, Ferdowsi University of Mashhad, Mashhad, Iran

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ABSTRACT

Introduction: We aimed to investigate of effect of left bundle branch block (LBBB) on perfusion and functional parameters in dipyridamole Tc99m-MIBI gated myocardial perfusion SPECT which may be helpful in interpretation of myocardial perfusion imaging.

Methods: We studied 70 patients with low pre-test probability of coronary artery disease in two groups: 35 patients with LBBB and 35 subjects with normal ECG. Both groups underwent two-day dipyridamole stress–rest Tc99m-MIBI GSPECT.

Results: From 35 patients with LBBB, 6, 12, and 3 patients had reversible, fixed and partially reversible defects respectively. In 35 patients with LBBB, 8 (22.9%), 6(17.1%) 15(42.9%) and 10 (28.6%) patients had perfusion defects in the apicoseptal, mid-anterior segments, mid-anteroseptal and mid-inferoseptal segments respectively. There was significant difference in TID ratio between two groups: LBBB group: 1.07±0.21 and control group: 0.96±0.14 (P=0.01). There was a significant difference in end systolic volume and ejection fraction between LBBB patients group and control group, while no significant difference was noticed in end-diastolic volume. Nineteen, 14 and 2 from 35 patients with LBBB had normal LV wall motion, paradoxical septal wall motion, and septal hypokinesia, respectively.

Conclusion: False positive septal, anterior and apicoseptal perfusion abnormalities are frequently seen on Tc99m-MIBI GSPECT, in patients with LBBB without CAD. Moreover reversible defects are frequently seen with Tc99m-MIBI. Even Tc99-MIBI and vasodilator stress do not increase diagnostic accuracy to clinically useful levels. Lower systolic performance and higher TID ratio could be seen in these patients.

Key words: LBBB; Gated SPECT; Myocardial perfusion; TID; Wall motion

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Corresponding author: Dr Vahid Reza Dabbagh Kakhki, Nuclear Medicine Research Center, Ghaem Hospital, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran. E-mail: dabbaghvr@mums.ac.ir

INTRODUCTION

On gated myocardial perfusion SPECT (GSPECT), false-positive (FP) perfusion defects and left ventricular (LV) functional abnormalities can be detected in some patients with left bundle branch block (LBBB) but without coronary artery disease (CAD) [1, 2]. Therefore, modified interpretation criteria and pharmacological vasodilator stress tests have been proposed to improve specificity for detecting CAD in patients with LBBB [2, 3]. Although FP results have been reduced, but not eliminated [2, 4]. Different theories for abnormal findings in the GSPECT in the presence of normal coronary arteries were proposed including :1) Lower septal oxygen demand secondary to impairing of septal thickening, diminished septal endothelial function, diminished coronary flow reserve, diastolic compression of septal perforators, compression of the septal microvascular, shorted diastolic filling time mainly in higher heart rates and a thinned septum as a part of the cardiomyopathic changes which all may leading to true decreased perfusion into the septum and 2) a false decrease in septal counts due to a partial-volume effect secondary to decreased septal wall thickening [5, 6].

On the other hand, GSPECT permits the simultaneous evaluation of several myocardial perfusion and left ventricular functional parameters and can help to better distinguish true and artifactual abnormalities [1, 2].

The aim of the present study was to analyze myocardial perfusion and LV functional indices using GSPECT in patients with LBBB having low probability of CAD as compared to the patients with normal electrocardiogram (ECG). In addition to perfusion abnormalities, LV volumes and systolic functional indices, we have studied transient ischemic dilation (TID) ratio in these two groups.

METHODS

Study population

We studied 70 patients (17 men and 53 women), ranging in age between 34 and 85 years (mean age: 57.46±13.39 years) referred to us for GSPECT. In all, 35 patients (8 men, 27 women, mean age 60.29 ± 13.67) with complete LBBB and 35control subjects with normal ECG (9 man, 26 women; mean age 54.63 ± 12.67) underwent dipyridamole stress-rest Tc99m-MIBI gated myocardial perfusion SPECT. All patients in both groups had low pre-test probability (<5%) for CAD. Likelihood of CAD was derived on the basis of Bayesian theory of prescan patient data. None of the patients had history of typical chest pain, diabetes mellitus, hypertension, smoking, hyperlipedemia, known coronary artery disease, earlier myocardial infarction, history of coronary revascularization, earlier myocardial surgery, history of CCU admission, artificial pacemaker, nonsinus rhythm, valvular heart disease, abnormal coronary angiography or any cardiac event during 2 years after myocardial perfusion SPECT. The study protocol was approved by the Ethics Committee of our institution and all patients gave their written informed consent to participation to the study.

ECG

LBBB was defined on surface 12-lead ECG as: QRS duration ≥120 ms, broad, notched R waves in the lateral precordial leads: V5 & V6 and leads I & aVL, small or absent initial r waves in the right precordial leads (V1 and V2) followed by deep S waves, absent septal q waves in left-sided leads, and a prolonged intrinsicoid deflection (>60 ms) in V5 and V6 [4].

Gated Myocardial perfusion SPECT

Both groups underwent two-day dipyridamole stress–rest Tc99m-MIBI GSPECT. On the first day, 740-925 MBq Tc99m-sestamibi was injected intravenously 4 min after the infusion of 0.142 mg/kg/min of dipyridamole for 4 minutes. Post-stress gated tomographic images were obtained 90 min later in supine position using a Dual-head g-camera (Dual-Head Variable-Angle E.CAM; Siemens)) equipped with low energy, high-resolution collimator, setting the energy photo-peak at 140 Kev with a 20% symmetric window. The two heads were placed in an L-shaped configuration. 32 projections were acquired for 25 sec per view over 180 arc commencing from the right anterior oblique to left posterior oblique view. We used a zoom factor of 1.45 and gating at 8 frames per cardiac cycle. The next day, rest GSPECT was performed 90 min after intravenous injection of 740-925 MBq Tc99m-sestamibi with same acquisition protocol.

The images were stored in a 64×64 matrix in the computer and reconstructed by filtered backprojection using a Butterworth filter (cut-off value was 0.35 cycle/cm for gated data but 0.55 cycle/cm for ungated data, order =5). No attenuation or scatter correction was applied. All reconstructed tomographic images were interpreted by consensus of 2 experienced physicians without knowledge of clinical and ECG data. Stress and rest tomograms images were evaluated visually with respect to defect reversibility and deemed normal, completely reversible, fixed defect, and partially reversible defects.

The 17-segment model and 5-point scale system (0, normal perfusion; 1, mildly reduced uptake ; 2, , moderately reduced uptake; 3, severely reduced uptake; and 4, absent uptake) was used for semi-quantitative assessment of myocardial perfusion (including six basal, six mid-ventricular and four apical segments in short axis slices and one additional mid-ventricular apical slice in the vertical long axis). The summed stress score (SSS), summed rest score (SRS) and the summed difference score (SDS=SSS-SRS) were calculated. We used a commercially available automated program, quantitative gated SPECT (QGS), for calculation of EDV, ESV and LVEF. TID ratio was calculated using ECTb software.

Statistical analysis

All analyses were done using SPSS 11.5 software. Data are expressed as mean± SD. The unpaired Student's "t"-test was used to evaluate the significant difference between LBBB and the control groups. A P value of less than 0.05 was considered significant.

RESULTS

In all 70 patients, visual scores were SSS=1.66±1.99 (0-9), SRS= 1.14±1.47 (0-6) and SDS= 0.51±1.18 (0-6). In 35 control subjects, 32 tomographic stress-rest SPECT images were interpreted as normal while 3 subjects had mild reversible defects. From 35 patients with LBBB, 14 patients had normal tomograms while 6, 12, and 3 patients had reversible, fixed and partially reversible (fixed + reversible) defects respectively.

Table 1 summarizes the overall results of the study based on 17-segement scoring system. The quantitative variables were normally distributed (checked by Kolmogorov-Smirnov test). In 35 patients with LBBB, 8 (22.9%) and 6 (17.1%) patients had perfusion defects in the apicoseptal and mid-anterior segments. The frequency of perfusion defects in the mid-anteroseptal and mid-inferoseptal segments were 15(42.9%) and 10 (28.6%) respectively.

In all 70 patients, TID ratio was 1.01±0.18; while there was significant difference between two groups: LBBB group: TID ratio= 1.07±0.21 and control group: TID ratio= 0.96±0.14 (P=0.01).

There was a significant difference in average end systolic volume (ESV) and ejection fraction (LVEF) between LBBB patients group and control group while no significant difference was noticed in end-diastolic volume (EDV) (Table 2).

All 35 control subjects had normal left ventricular wall motion, but 19, 14 and 2 from 35 patients with LBBB demonstrated normal LV wall motion, paradoxical septal wall motion, and septal hypokinesia, respectively(P<0.001).

DISCUSSION

In our study, among the patients with LBBB, 21 (i.e 60 %) were found to have abnormal scitigraphic tomograms, nine patients with some reversibility while only 12 patients had only fixed defects. Septal hypokinesia and paradoxical septal wall mtion, higher ESV, lower LVEF and higher TID ratio were noticed in patients with LBBB as compared to the control group.

Previous studies reported 4% to 84% false-positive perfusion defects due to LBBB resulting limited value for Tl-201 MPI in these patients [7-13]. These false positive findings are more frequently noted with exercise or dobutamine stress protocols than adenosine or dipyridamole protocols [6].

MPI using pharmacologic dilatation and Tc-99m sestamibi have been recommended to improve the specificity in patients with LBBB [3]. It is reported that 4% of the patients with LBBB had a false-positive reversible septal defect using Tl-201 adenosine MPI [7, 13]. During exercise, tachycardia may shorten the diastolic period, worsen abnormal segmental wall contraction and thickening while during vasodilator stress without inducing significant tachycardia, homogeneous increase in coronary blood flow throughout the myocardium was observed [3].

On the other hand, there is significant difference between the Tl-201 and Tc-99m sestamibi kinetic and imaging patterns, because in 60-90 minutes time elapsed between stress test and acquisition of Tc99m-MIBI images, the heart rate returns to baseline as opposed to the short time interval between stress end and acquisition of Tl-201 images [3]. So it is suggested that there is usually artifactual reversible perfusion defects using Tl-201 MPI in LBBB, whereas fixed septal perfusion defect is typical finding in the Tc-99m sestamibi MPI [3].

In the present study, 70 patients with low probability of CAD in two groups, 35 with complete LBBB and 35 controls GSPECT, were evaluated. Among the patients with LBBB, 21 (i.e 60 %) were found to have abnormal scintigraphic tomograms, a finding relatively higher than other studies. Form these 21 patients, nine patients had some reversibility while only 12 patients had only fixed defects.

Previous studies recommended that in addition to reversibility, apex or anterior wall defect may be suggestive of true CAD [6, 14].

Fallahi et al. [15] proposed that coexisting perfusion abnormalities outside the septal and anteroseptal regions are more suggestive of CAD, especially in women. We found that there is some perfusion defects in the apicoseptal and mid-anterior segments in patients with LBBB.

Table 1. Mean±SD of the scores for 17 segments of the left ventricular myocardium in two patients groups(controls and patients with LBBB) in both stress and rest tomograms.

Segment	Imaging Phase	Controls	LBBB	P value
Apical	Stress	0	0.06±0.24	0.160
	Rest	0	0.06±0.24	0.160
Anteroapical	Stress	0.60±0.81	0.89±0.93	0.176
	Rest	0.40±0.55	0.69±0.80	0.086
Apicolateral	Stress	0	0	-
	Rest	0	0	-
Inferoapical	Stress	0.06±0.24	0.06±0.24	1.000
	Rest	0.03±0.17	0.06±0.24	0.562
Apicoseptal	Stress	0	0.26±0.50	0.004
	Rest	0	0.20±0.47	0.017
Mid-anterior	Stress	0	0.23±0.60	0.030
	Rest	0	0.11±0.32	0.044
Mid-anterolateral	Stress	0	0	-
	Rest	0	0	-
Mid-inferolateral	Stress	0	0.03±0.17	0.324
	Rest	0	0.03±0.17	0.324
Mid-inferior	Stress	0.06±0.24	0	0.160
	Rest	0.06±0.24	0	0.160
Mid-inferoseptal	Stress	0	0.37±0.65	0.002
	Rest	0	0.20±0.47	0.017
Mid-anteroseptal	Stress	0	0.57±0.74	<0.001
	Rest	0	0.40±0.65	0.001
Basal-anterior	Stress	0	0	-
	Rest	0	0	-
Basal-anterolateral	Stress	0	0	-
	Rest	0	0	-
Basal-inferolateral	Stress	0	0	-
	Rest	0	0	-
Basal-inferior	Stress	0.03±0.17	0	0.324
	Rest	0.03±0.17	0	0.324
Basal-inferoseptal	Stress	0	0.03±0.17	0.324
	Rest	0	0	-
Basal-anteroseptal	Stress	0	0.09±0.37	0.183
	Rest	0	0.03±0.17	0.324
Summed Stress Score	-	0.74±0.92	2.57±2.34	<0.001
Summed Rest Score	-	0.49±0.70	1.80±1.73	<0.001

Table 2. Left ventricular ejection fraction (LVEF), end-systolic volume (ESV) and end-diastolic volume (EDV) in two groups: patients with LBBB and subjects with normal electrocardiogram (ECG).

Variable	LBBB Group	Normal ECG Group	P value
LVEF	63.50±13.26	79.91±13.71	<0.001
ESV	21.76±11.39	12.35±10.01	0.001
EDV	55.94±16.87	52.76±16.79	0.439

Based on our study, the presence of perfusion defects in the anterior segments, apex or even presence of reversibility did not help significantly in differentiating TP from FP cases. Also some studies reported that apical defects are sensitive but not specific or accurate [14].

The discrepancy between results of different studies may be related in part to dissimilar study populations and definitions of coronary artery disease by angiography. So we believe that sometimes interpretative recommendations based on presence of perfusion defects in the apicoseptal, and anterior wall might not be helpful. Special care needs to be applied in interpretation of GSPECT of these patients.

Other findings in our study were higher ESV and lower LVEF in patients with LBBB suggesting impaired in systolic performance. We noted septal hypokinesia in 2, paradoxical septal wall motion in 14 from 35 patients. Other septal wall motion abnormality beside the paradoxical septal wall motion also could be seen. Another unique aspect of this study was assessment of TID ratio. TID ratio in patients with LBBB but free of CAD was higher than control group. It might be due to impaired systolic performance, diminished coronary flow reserve, higher heart rate during stress imaging shortened diastolic time and increased diastolic compression of septal perforators, decreased septal wall thickening or even may be due to true microvascular disease. Finally, this finding may be valuable in assessment of prognosis.

Study limitations

Lack of coronary angiography as a gold standard was the major limitation of this study because of ethics consideration. So we studied two groups with low pre-test probability of CAD based on Bayesian theory.

CONCLUSION

False-positive septal, anterior and apicoseptal perfusion abnormalities are frequently seen on Tc99m-MIBI GSPECT, in patients with LBBB with low pretest probability of CAD which may decrease specificity of the test in LAD territory. Moreover reversible defects are frequently seen with Tc99m-MIBI. So, MPI even following vasodilator stress do not increase diagnostic accuracy to clinically useful level. Lower systolic performance and higher TID ratio in patients with LBBB but free of CAD must be studied specially to clarify the prognostic aspect of the procedure.

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