

Gated ^{99m}Tc -MIBI myocardial perfusion SPECT in patients with right bundle branch block but without evidence of coronary artery disease

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(Received 12 May 2013, Revised 9 June 2013, Accepted 16 June 2013)

ABSTRACT

Introduction: We aimed to investigate the effect of right bundle branch block (RBBB) on perfusion and functional parameters in dipyridamole stress/rest Tc^{99m}-MIBI gated myocardial perfusion SPECT (GSPECT) which may be helpful in interpretation of myocardial perfusion imaging.

Methods: We studied 73 patients with low pre-test likelihood of coronary artery disease in two groups: 38 patients with RBBB and 35 subjects with normal ECG. Both groups underwent two-day dipyridamole stress–rest Tc^{99m}-MIBI GSPECT. Two groups were matched. There was no significant difference in sex and age variable between two groups.

Results: Visual calculated SSS and SRS in all patients were between 0 and 3. Regarding the prone images, diaphragmatic attenuation and breast attenuation, all patients GSPECT findings were within normal limits. There was no significant difference in TID ratio between two groups: RBBB group: TID ratio= 1.02 ± 0.16 and control group: TID ratio= 0.96 ± 0.14 ($P=0.09$). There was no significant difference in left ventricular end-systolic volume, end-diastolic volume, ejection fraction, summed stress and rest motion & thickening scores between RBB patients group and control group. No regional LV wall motion abnormality was noticed in any patient in either group.

Conclusion: High normality rate of the LV myocardial perfusion and functional indices in the presence of RBBB was noticed in gated Dipyridamole stress/rest Tc-^{99m} sestamibi myocardial perfusion SPECT. No remarkable false positive perfusion findings or abnormal LV functional indices acquired by GSPECT in this group of patients.

Key words: RBBB; Myocardial perfusion; Gated SPECT; Coronary artery disease

Iran J Nucl Med 2013;21(2):60-64

Published: October, 2013

<http://irjnm.tums.ac.ir>

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INTRODUCTION

Gated myocardial perfusion SPECT (GSPECT) with simultaneous assessment of myocardial perfusion and left ventricular (LV) function is an accurate diagnostic and prognostic test for coronary artery disease (CAD) [1, 2]. Patients with baseline electrocardiogram (ECG) abnormalities are frequently referred to perform myocardial perfusion imaging (MPI). However, some patients with conduction abnormalities may have abnormal perfusion findings without significant CAD [2-5]. It is documented that in the left bundle branch block (LBBB), false positive myocardial perfusion defects as well as left ventricular functional abnormalities especially in the anteroseptal wall can be detected even in the absence of stenosis in the left anterior descending artery territory [2, 5-7].

Although in routine clinical practice, the interpretation of GSPECT images in patients with right bundle branch block (RBBB) seems less problematic, some cases of false positives findings have been reported [2-5]. Few studies investigated the effect of RBBB on the GSPECT findings [2-5, 8-10]. The aim of the present study was to determine perfusion tomogram pattern and LV functional indices using GSPECT in patients with RBBB having low probability of CAD as compared to the patients with normal ECG.

METHODS

Study population

In a prospective manner, the study population consisted of 73 patients (21 male and 52 female), ranging in age 34-85 years (mean age: 55.53 ± 11.71 years) referred to nuclear medicine department for GSPECT. From 73 patients, 38 patients (12 male, 26 female, mean age 56.37 ± 10.85) with RBBB and 35 control subjects with normal ECG (9 male, 26 female; mean age 54.63 ± 12.67) underwent Dipyridamole stress-rest Tc99m-MIBI gated myocardial perfusion SPECT. Two patient groups were matched based on age and sex. No significant difference was noticed between two groups based on sex ($P=0.61$) and age ($P=0.53$). 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 studied patient had history of typical chest pain, hypertension, diabetes mellitus, hyperlipidemia, smoking, known coronary artery disease, 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 for participation in the study.

ECG

RBBB was defined on surface 12-lead ECG based on the following criteria [5, 11]: QRS duration ≥ 120 msec, wide and deep S waves in left precordial leads: V5 and V6, broad notched R waves (rsr', rsR' or rSR' patterns) in right precordial leads: V1 and V2.

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 & prone positions 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. Thirty two 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 in the supine position 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) [1]. 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

end-diastolic volume (EDV), end-systolic volume (ESV) and left ventricular ejection fraction (LVEF). Transient ischemic dilation ratio (TID ratio) was calculated using ECTb (Emory Cardiac Toolbox) software.

Statistical analysis

All analyses were done using SPSS 20 software. Continuous variables are described by the mean value \pm standard deviation (SD). The unpaired Student's "t"-test and Chi-Square test were used to test for significant difference between RBBB and the control groups. A P value of less than 0.05 was considered significant.

RESULTS

Visual calculated SSS and SRS in all patients were between 0 and 3, with mean \pm SD: SSS=0.70 \pm 0.95, SRS= 0.41 \pm 0.68 and SDS= 0.19 \pm 0.46. In 35 control subjects, 32 tomographic stress-rest SPECT images were interpreted as completely normal while 3 subjects had minimal reversible defects. From 38 patients with RBBB, 34 patients had completely normal tomograms while 2, 1 and 1 patients had minimal reversible, fixed and partially reversible (fixed + reversible) defects respectively ($P=0.54$). After review of the supine and prone images and consensus of nuclear medicine specialists, these

findings in the anteroapical, inferior and inferoseptal segments in these 7 patients, attributed to breast and diaphragmatic attenuation. So, all perfusion tomograms were within normal limits. There was zero score in all 17 segments in the stress and rest phase except for: anteroapical, inferoapical, mid-inferior, mid-inferoseptal, and basal inferior segments (Table 1).

In all 73 patients, TID ratio was 0.99 \pm 0.15; while there was no significant difference between two groups: RBBB group: TID ratio= 1.02 \pm 0.16 and control group: TID ratio= 0.96 \pm 0.14 ($P=0.09$).

There was no significant difference in ESV, EDV, LVEF, summed stress and rest motion and thickening scores between RBB patients group and control group (Table 2). No regional LV wall motion abnormality was noticed in any patient in both groups.

DISCUSSION

Cardiac conduction abnormalities are noticed in a significant percentage of cardiology patients. On the other hand, it may be a diagnostic problem for conventional exercise test [2].

Table 1. Mean \pm SD of the scores for the left ventricular myocardium segments in two patients groups (controls and patients with RBBB) in both stress and rest tomograms. Score of other segments was 0 in both two groups (not mention in the Table).

Segment	Imaging Phase	Controls	RBBB	P value
Anteroapical	Stress	0.60 \pm 0.81	0.42 \pm 0.79	0.34
	Rest	0.40 \pm 0.55	0.21 \pm 0.58	0.16
Inferoapical	Stress	0.06 \pm 0.24	0.08 \pm 0.27	0.71
	Rest	0.03 \pm 0.17	0.08 \pm 0.27	0.35
Mid-inferior	Stress	0.06 \pm 0.24	0.03 \pm 0.16	0.51
	Rest	0.06 \pm 0.24	0.00	0.16
Mid-inferoseptal	Stress	0.00	0.11 \pm 0.45	0.16
	Rest	0.00	0.05 \pm 0.23	0.16
Basal-inferior	Stress	0.03 \pm 0.17	0.03 \pm 0.17	0.95
	Rest	0.03 \pm 0.17	0.00	0.32
Summed Stress Score	-	0.74 \pm 0.92	0.66 \pm 0.99	0.71
Summed Rest Score	-	0.49 \pm 0.70	0.34 \pm 0.67	0.37

Table 2. Left ventricular functional indices derived from the QGS (Quantitative gated SPECT) in two groups: patients with RBBB and subjects with normal electrocardiogram.

Variable	Imaging Phase	Controls	RBBB	P value
Ejection Fraction	Stress	80.82±11.87	78.84±13.37	0.51
	Rest	79.91±13.71	79.11±13.90	0.81
End-diastolic volume	Stress	50.62±16.35	48.11±18.63	0.55
	Rest	52.76±16.79	48.24±17.55	0.27
End-systolic volume	Stress	11.18±8.90	12.19±10.67	0.66
	Rest	12.35±10.01	11.84±10.42	0.83
Summed motion score	Stress	1.12±2.72	0.84±2.77	0.67
	Rest	1.41±3.48	1.08±3.15	0.45
Summed thickening score	Stress	0.00	0.03±0.16	0.053
	Rest	0.26±1.38	0.24±1.32	0.89

In spite of LBBB, RBBB has received very little attention in the literature [2].

Beyond that there are few previous studies about the effect of the RBBB on myocardial perfusion imaging, they are limited to perfusion analysis, and mainly based on exercise stress/redistribution Tl-201 imaging [3, 5, 9, 10]. Some studies reported false-positive perfusion defects in patients with RBBB in the inferior, inferolateral, or inferoapical segments, however the frequency of false positive findings were not high [3-5, 9, 10].

This study focused on the effect of RBBB in the two-day protocol dipyridamole stress/rest Tc99m-MIBI gated myocardial perfusion SPECT using a case-control study. According to our findings, RBBB does not have any effect on the perfusion tomograms, gated functional LV indices, and perfusion, motion and thickening scores.

Many studies demonstrated that asynchronous ventricular contraction in LBBB can create artefactual perfusion defects especially in the anteroseptal region [5, 12-14]. In the RBBB, while the right ventricular activation is delayed, the left ventricle is rather normally activated [5, 11]. So this is an explanation for absence of artefactual perfusion defects in the LV myocardial walls in these patients.

Different findings in our study as compared to some previous studies could be due to type of stress (vasodilator stress), different physical characteristics and tracer kinetics of Tc-99m Sestamibi. Javadi et al. reported a patient with RBBB which had perfusion defect on exercise stress/rest myocardial perfusion SPECT while Dipyridamole stress myocardial

perfusion SPECT and coronary artery angiography were normal [15]. Stress type can affect ventricular contraction and exercise can aggravate ventricular asynchrony as compared to the vasodilators [5]. Up to now, the possible effects of different stress types in GSPECT have not been studied in patients with RBBB. Vasodilator stress may be suitable for RBBB similar to LBBB³. On the other hand, we acquired prone images to rule out the diaphragmatic attenuation. Other previous studies did not explain anything about the inferior segments findings, prone images and effect of diaphragmatic attenuation. So it is possible that some of their findings in the inferior, inferolateral and inferoseptal segments were related to diaphragmatic attenuation. Küçük et al [3] reported the inferior and inferolateral defects using exercise Tl-201 MPI. But they didn't mention anything about diaphragmatic attenuation effect.

Paredes et al [2] reported specificity of SPECT in the presence of RBBB is very similar to that reported in patients without intraventricular conduction abnormalities. Inanir et al [5] reported similar findings to our results. In their study, patients underwent the stress/rest Tc99m-Sestamibi MPI using a single-day protocol. They used vasodilator Dipyridamole stress for most studied patients and exercise test for few patients.

Study limitations

In our study, we didn't compare the scan findings with coronary angiography. As it is noticed in the "method" section we studied patients with low likelihood of CAD (<5%). The patients didn't have

any cardiac event during 2 years after myocardial perfusion SPECT.

CONCLUSION

In RBBB, no remarkable false positive perfusion findings or abnormal LV functional indices acquired by dipyridamole stress/rest Tc-99m sestamibi myocardial perfusion gated SPECT was noticed. Tc-99m sestamibi GSPECT can be used for exclusion of true myocardial perfusion abnormality in patients with RBBB.

Acknowledgements

This paper is the result of Dr. Neda Shafizadeh residency thesis, which was supported by Deputy of Research, Mashhad University of Medical Sciences. The authors wish to thank Vice Chancellor for Education and the Research Committee of the University for their support.

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