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Original Article

COMPARISON OF INCREMENTAL PROGNOSTIC VALUE OF GATED AND NON-GATED SPECT MYOCARDIAL PERFUSION IMAGING: DOES GATING MATTERS?

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ABSTRACT

Objectives: Gated Single photon emission computerized tomography (SPECT) myocardial perfusion imaging (MPI) has better diagnostic accuracy than non-gated SECT MPI. The objective of this study was to evaluate prognostic strength of gated and non-gated SPECT MPI in same patients' population.

Material and Methods: This was a prospective study conducted at Nuclear Cardiology Department of Karachi Institute of Heart Diseases (KIHD), Karachi from March 2009 till January 2011. We recruited 452 consecutive patients (mean age of 57 ± 12 years; male: female ratio of 280:172) who were referred for stress (exercise or dipyridamole) SPECT scan for evaluation of known or suspected CAD. Stress SPECT MPI was acquired in gated and non-gated modes while resting SPECT were acquired only in non-gated mode in all patients. Patients were followed up for a period of 18-24 months regarding major adverse cardiac events (MACE).

Result: For gated and non-gated MPI, SSS of 0, 1-3 and 4-8 were seen in 150 (33%) : 80 (18%), 130 (29%) : 165 (37%) and 90 (20%) : 87(19%) respectively (significant p values). While a non-significant SSS >8 was found in 82 (18%) : 87 (19%) for gated and non-gated MPI. During 18-24 months follow-up, no MACE was observed for SSS 0 in both sets of studies while significantly higher event rate was noted for GMPI than NGMPI group [5(3.80%) Vs 1 (0.60%)] for SSS 1-3. For SSS 4-8 and >8, non-significant but higher event rates were seen in both sets of studies [7(7.70%) Vs 8 (6.60%) and 8(9.80%) Vs 11 (12.60%) respectively]. Kaplan Meier survival plot for fatal MI in combination with left ventricular function (LVEF) showed significantly lower event free survival for GMPI than NGMPI studies (Log Rank = 4.68, p <0.05). Kaplan Meier survival plot for non-fatal MI in combination with left ventricular function showed lower but non-significant event free survival for GMPI than NGMPI studies (Log Rank = 2.799, p <0.094).

Conclusions: We conclude that gating adds better incremental prognostic value to SPECT MPI and SSS 0 has high NPV for both GMPI and NGMPI. SSS 1-3 for GMPI has better diagnostic accuracy than NGMPI but for SSS ≥4 the event rates are similar. LVEF estimated by GMPI with higher SSS is a predictor of fatal MI than non-fatal MI.

Key Words: Gated SPECT, Non-gated SPECT, myocardial perfusion Imaging, prognostic value, sum stress score, fatal myocardial infarction.

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INTRODUCTION

Single photon emission computerized tomography (SPECT) myocardial perfusion imaging (MPI) is the most widely used non-

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invasive imaging tool for diagnosis and follow up of patients with CAD and has good sensitivity but low specificity. This low specificity is caused by false positive defects (like anterior wall attenuation by breast, diaphragamatic attenuation in male and septal defects with left bundle branch block)[1]. Specificity of non-gated SPECT MPI can be improved by using vasodilators and gating[2], scanning in prone[3] and using attenuation correction either CT based[4,5]' or external radiation source[6]. In Gated SPECT (GSPECT) R wave of ECG (end diastole) is used to trigger the acquisition of data and R-R interval (a cardiac cycle is divided into 8-24 frames for dynamic data acquisition[7]. Gated SPECT (GSPECT) allows assessment of myocardial perfusion and function in one study which ensures good diagnostic and incremental prognostic strength for patients with known or suspected CAD[8,9].

The objective of this study was to evaluate prognostic strength of gated and non-gated SPECT MPI in same patients' population.

METHODS

Study Design, Site and Duration: This was a prospective study conducted at Nuclear Cardiology Department of Karachi Institute of Heart Diseases (KIHD), Karachi, Pakistan from March 2009 till January 2010. It was duly approved by the ethical committee of the institute. We recruited 452 consecutive patients who were referred for stress (exercise or dipyridamole) SPECT scan for evaluation of known or suspected CAD. All patients/families were interviewed on telephone (18-24 months follow up, mean ±3 months) regarding major adverse cardiac events (MACE) like fatal myocardial infarction (MI) and non-fatal events including MI and history of revascularization.

Study Population: Study included 452 consecutive patients with a mean age of 57 ± 12 years and a male: female ratio of 280:172 (62%:38%). Risk factor assessment revealed that 289 (64%) were hypertensive, 186 (41%) were diabetic, 127 (28%) were dyslipidemic, 113 (25%) were smoker and positive family history for CAD was found in 98 (22%) [Table1].

Table 1: Demographic distribution of patient

Variables	n=452
Age (mean ± SD) yrs	57 ± 12
Male	280 (62%)
Female	172 (38%)
Risk Factor	
Hypertension	289 (64%)
Diabetes Mellitus	186 (41%)
Dyslipidemia	127 (28%)
Family history CAD	98 (22%)
Smoker	113 (25%)
Stress protocol	
Bruce	249 (55%)
Persantin	203 (45%)
%MPHR	88 ± 8
METs	8.40 ± 3.98
LV Function	
%LV Ejection Fraction	58 ± 12
End Diastolic Volume (ml)	98 ± 36
End Systolic Volume (ml)	44 ± 24
MPI findings	
Abnormal	172 (38%)
Fixed	95 (21%)
Reversible	77 (17%)
TID	35 (08%)
SSS	6 ± 5

*p<0.05
SD= Standard Deviation
MPHR=Maximum Age Predicted Heart Rate
MET=Metabolic Equivalent Task
MPI=Myocardial Perfusion Imaging
TID=Transient Ischemic Dilatation
SSS=Sum Stress Score

Table 2: Change in sum stress scoring from non-gated to gated MPI.

Variables	Gated MPI	Non-Gated MPI	p-values
SSS 0	150 (33%)	80 (18%)	0.0001*
SSS 1-3	130 (29%)	165 (37%)	0.0129*
SSS 4-8	90 (20%)	120 (27%)	0.0162*
SSS>8	82 (18%)	87 (19%)	0.7630

*p<0.05
SSS=Sum Stress Score

Acquisition Protocol: All patients underwent same day (rest-stress or stress-rest) myocardial perfusion SPECT imaging using Tc-99m labeled Methoxy IsoButyl Isonitrile (MIBI). 10-15 mCi of Tc-99m MIBI was administered intravenously for first study (rest in rest-stress or stress in stress-rest protocol) and 25-30 mCi for second study (stress in rest-stress or rest in stress-rest protocol). Stress studies were acquired in both non-gated and gated modes while only non-gated rest SPECT acquisitions were performed in all patients using dedicated dual head cardiac (Cardio MD, Philips) gamma camera with low energy all purpose (LEAP) collimator, 32 projections around a 180 degree arc, a 64 x 64 matrix and 16 frames per cardiac cycle. Image reconstruction and LV functional parameters (EF, EDV, ESV and wall motion [WM]) were contemplated by using commercially available Astonish® and Autoquan® software packages respectively. Sum stress score (SSS) for stress and non-gated stress studies were also measured. These were grouped as SSS 0, SSS 1-3, SSS 4-8 and SSS >8 for gated and non-gated MPI.

Stress Protocol: Dynamic exercise (either Bruce or Modified Bruce protocol) was performed using treadmill and exercise was considered adequate when patient achieved ≥85% of age predicted target heart rate (220-age) or developed typical angina or dyspnea or > 2mm ST depressions in 2 or more leads. Beta blockers, calcium blocker and long acting nitrate were stopped 24-48 hours prior the test. Dipyridamole intervention was performed (0.567 mg/kg for 4 minute) in patients who were unable to perform dynamic exercise or having LBBB on resting ECG or specifically asked by the referring physicians due to limited exercise capacity. Tea, coffee and xanthine derivatives were stopped 24 prior in patients scheduled for dipyridamole test. A rise in ≥10 beats (from baseline) or drop of ≥10 mmHg of systolic blood pressure with or without symptoms or ST changes were considered as adequate response to dipyridamole. Tc-99m MIBI was given 1 minute before terminating exercise or 3-4 minute after dipyridamole infusion. Intravenous aminophylline (75-125 mg) was given to all patient 2-3 minutes after radiotracer to antagonize the effect of dipyridamole.

Statistical Analysis: Comparisons between patient groups were performed using student-t test for continuous variables and the X^2 test for categorical variables. Continuous variables were described by mean ± standard deviation (SD). Kaplan-Meier cumulative survival analysis for major cardiac events like fatal and non-fatal MIs was performed, and survival curves were compared by the Logrank test. Statistical significance was defined as $P<0.05$.

RESULTS

The demographic characteristics of studied patients are presented in Table 1. For gated and non-gated MPI, SSS of 0, 1-3 and 4-8 were seen in 150 (33%): 80 (18%), 130 (29%) : 165 (37%) and 90 (20%) : 87(19%) respectively (significant p values). While a non-significant SSS >8 was found in 82 (18%): 87 (19%) for gated and non-gated MPI.

During 18-24 months follow-up, no MACE was observed for SSS 0 in both sets of studies while significantly higher event rate was noted for GMPI than NGMPI group [5(3.80%) Vs 1 (0.60%)] for SSS 1-3. For SSS 4-8 and >8, non-significant but higher event rates were seen in both sets of studies [7(7.70%) Vs 8 (6.60%) and 8(9.80%) Vs 11 (12.60%) respectively] (Figure 1).

Kaplan Meier survival plot for fatal MI in combination with left ventricular function (LVEF) showed significantly lower event free survival for GMPI than NGMPI studies (Log Rank = 4.68, p <0.05) [Figure 2]. Kaplan Meier survival plot for non-fatal MI in combination with left ventricular function showed lower but non-significant event free survival for GMPI than NGMPI studies (Log Rank = 2.799, p <0.094) [Figure 3].

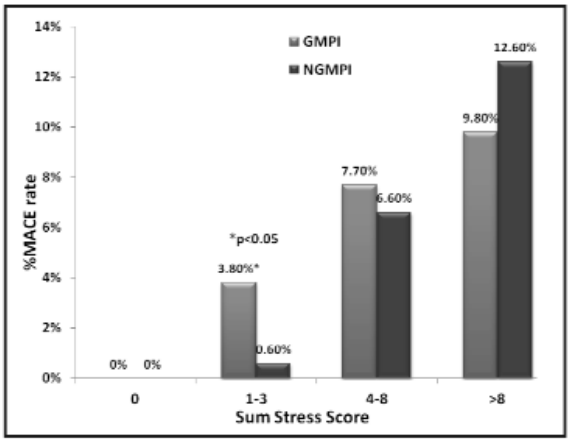

Figure 1: Comparative anlaysis of % Major Cardaic Event rate in gated and non-gated myocardial perfsion imaging in relation with sum stress scoring.

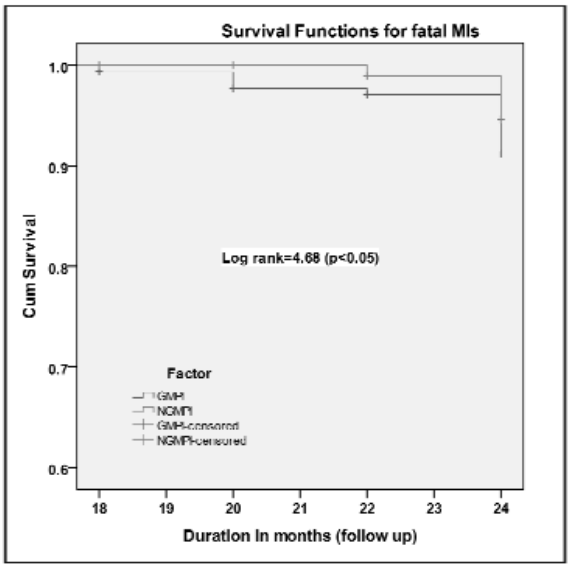

Figure 2: Comparison of survival plots for fatal myocardial infraction from non-gated to gated myocardial perfusion imaging in combination with LV function.

DISCUSSION

SPECT MPI has limited specificity due to false positive result caused by predominantly by attenuation artifacts. Gated (using R wave of ECG) is the most common method to detect these artifacts and hence ascertains confidence to the reporting nuclear cardiologists for correct diagnosis and predicting the prognosis. In this study SSS 0 (no perfusion defect or a normal MPI)

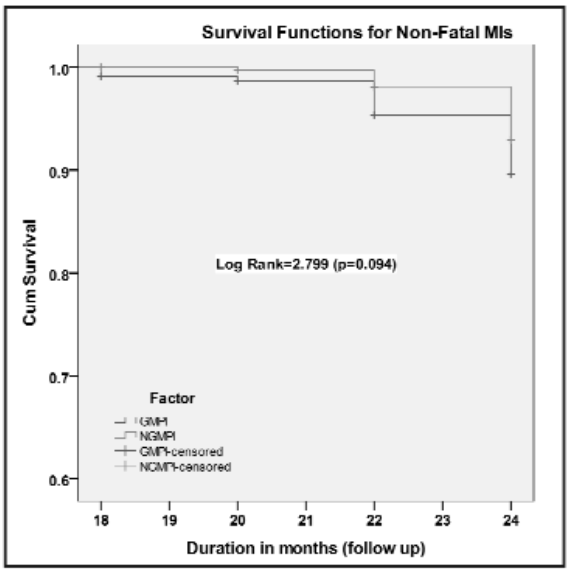

Figure 3: Comparison of survival plots for non-fatal myocardial infraction from non-gated to gated myocardial perfusion imaging in combination with LV function.

estimated for GMPI and NGMPI had no associated MACE and this ensures high negative predictive value which is in concordance with a large body of published data[10,11]. SSS 1-3 revealed a MACE rate significantly lower for NGMPI while higher for GMPI. This reflects high false positive result associated with NGMPI and higher true positive rate for GMPI due to better diagnostic accuracy ensured by gating[12]. For SSS 4-8 and >8, MACE was higher for NGMPI and GMPI although non-significant but this signifies a higher true positive results with higher SSS. When we analyzed perfusion data (SSS) in correlation with LVEF and volumes measured by GMPI, it was realized that LVEF was the better predictor of higher MACE in patient with SSS >4. This finding concurs with published studies with proven higher incremental prognostic value of LV functional parameters like LVEF <45% and ESV >70 ml with GMPI[13]. Our data also shows that GMPI has significantly low event free survival for fatal MI but for non-fatal MI both GMPI and NGMPI have similar event free survival (non-significant p values). This again denotes the better predictive value of lower EF for fatal MI as has been stated in various studies[13].

CONCLUSION

We conclude that gating adds better incremental prognostic value to SPECT MPI and SSS 0 has high NPV for both GMPI and NGMPI. SSS 1-3 for GMPI has better diagnostic accuracy than NGMPI but for SSS ≥4 the event rates are similar. LVEF estimated by GMPI with higher SSS is a predictor of fatal MI than non-fatal MI.

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