CORRELATION OF PERFUSION AND CONTRACTILITY OF LEFT VENTRICLE MYOCARDIUM ON GATED MYOCARDIAL PERFUSION SCINTIGRAPHY

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Background: Gated Single Photon Emission Computerized Tomography (SPECT) is a modality which is helpful in the detection of wall motion, thickening and ejection fraction of left ventricle. The purpose of this study was to correlate the ungated and gated SPECT in evaluation of left ventricle dysfunction. **Method:** It was a prospective study done at Institute of Radiotherapy and Nuclear Medicine (IRNUM), Peshawar, in 2001/02. 76 patients (47 male and 29 female) with an average age of 52±11 years were inducted in this study. All patients underwent two days stress-rest Tc-99m MIBI (Methoxy Isobutyl Isonitrile) gated SPECT scan where 1110 MBq (30 mCi) was injected intravenously. Eight frames gating technique (variable fixed temporal resolution) of ECG was used to gate the cardiac cycle and whole acquisition was completed in 30 minutes. **Results:** This technique very well evaluated the perfusion as well as wall motion/thickening (W/M/T) status of left ventricle. Out of 76 scans, 30% were normal, 22% transmural infarct, 25% partial thickness infarct, and 22% reversible ischemia. By doing the 20 segmental analyses, total 1520 segments were analyzed that revealed good concordance of perfusion with W/M/T in 78% of segments while 22% segments showed poor concordance. Out of these 22%, 12% were having more wall motion abnormalities than that of perfusion, while in 10%, it was vise versa. **Conclusion:** Results of this study shows good correlation between gated and ungated SPECT for evaluation of left ventricle dysfunction ($r = 0.73$, $p=0.01$).

Key Words: Tc-99m MIBI; Ischemic heart disease; Gated SPECT.

INTRODUCTION

The purpose of this study was to correlate the ungated Single Photon Emission Computerized Tomography (SPECT) with gated SPECT in evaluation of left ventricle dysfunction. Radionuclide scan in cardiology started with simple planar technique in early 1970. It was done to evaluate the perfusion status of myocardium but for wall motion, radionuclide ventriculography (RNVG) used to be performed. RNVG still have the role in detection of wall motion but planar technique is quite obsolete now. Most of the cardiologists rely on SPECT technique where gamma camera acquires the data in at least 64 views while in planar, it was just three. Most of the centers in Pakistan are now performing SPECT scan while some are also performing gated SPECT scan. Extra advantage of gated SPECT is the detection of both perfusion and wall motion in a single go.

Patient presenting with chest pain and exertional dyspnea needs baseline investigation. Electrocardiography (ECG), chest X-Ray and cardiac enzymes are the most commonly done investigations. However, if it is inconclusive, then ETT or cardiac SPECT scan is the investigation of choice.[1] (Table: 1) SPECT scan only evaluate the perfusion status of the myocardium, however, with gated SPECT, one can comment both on perfusion as well as wall motion/thickening (W/M/T) status of the myocardium[2]. Its cine mode helps in detection of stunned/hibernating myocardium and ruling out certain attenuation artifacts. It also helps in calculation of end diastolic volume (EDV), end systolic volume (ESV) and ejection fraction (EF). Comparison of ungated with gated SPECT may save the patient from unnecessary interventions. For example, patients having mild to moderate reversible ischemia with good left ventricle (LV) function just need close follow-up with aggressive medical management.[3] Similarly, patient having stunned myocardium (good perfusion but reduced function) only needs close follow-up.[4,5] These functional defects usually get reverse spontaneously within three months.[6] However, patients having hibernating myocardium (poor perfusion with reduced function) needs revascularization.[7]

Table 1. Overall sensitivity and specificity for detection of coronary artery disease (>50% stenosis).[1]

Tests	Sensitivity	Specificity
Exercise ECG	60%	85%
Stress Tl-201 SPECT	90%	80%
Stress Tc-99m MIBI SPECT	90%	90%
Stress PET	95%	95%
Stress Echocardiography	80%	90%

[PET: Positron Emission Tomography, ECG: Electrocardiography, Tl-201: Thallium 201, SPECT: Single Photon Emission Computerized Tomography]

MATERIAL AND METHODS

76 patients (47 males and 29 females) with an average age of 52 ± 11 years underwent two days stress-rest gated SPECT scan. All patients were called empty stomach for at least four hours before scan. 1110 MBq (30 mCi) of Tc-99m MIBI (Methoxy Isobutyl Isonitrile) was injected intravenously to all patients. Stress was given either alone with treadmill or in combination with Dipyridamole. Combination technique was used in those patients who could not exercise completely or there was a pre-test probability of sub-maximal exercise. Patient having left bundle branch block (LBBB) was given only pharmacological stress with Dipyridamole (n=3). Tc-99m MIBI was injected intravenously one minute before peak stress and patient was asked to continue the exercise at same level one minute more. After completion of stress, patients were asked to take light fatty meal and acquisition was started after 45 minutes of tracer injection. Fatty meal helps in excretion of MIBI from liver and gall bladder, which is necessary for better visualization of LV. Acquisition, was started under the large field of view (LFOV) gamma camera (ECAM SIEMENS) using high resolution collimator. ECAM has two basic executing systems i.e., "esoft" for acquisition and "ICON" for processing purposes. Gating device is attached to the gamma camera and its three limb leads are attached to the patient accordingly. Eight frames gating technique (variable fixed temporal resolution) of ECG was used to gate the cardiac cycle. Patient lies in supine position and camera's head rotate from right anterior oblique (RAO) to left posterior oblique (LPO) position in about 30 minutes. (Figure 1) In this way, it completes an arc of 180 degree. Patient was advised not to move or cough during acquisition as it produces motion artifact. After completion of acquisition, data were analyzed for any motion error and then complete processing was performed. Minimal motion noted during acquisition in some patients (n=6) was corrected by motion correction software. ECAM has the facility that it converts the gated data into ungated one. In this way, both perfusion as well as W/M/T status of LV can be evaluated. After the visual interpretation (qualitative analysis), Bull's eye view was generated. It helps in quantitative analysis of the LV. 20 segmental analysis both for perfusion and wall motion was performed and each segment was categorized according to five point scoring system from 0-4[8] (Figure 2). Zero represents absent perfusion and akinesia/dyskinesia while four represents normal perfusion/wall motion status.[9,10] Perfusion defects with score zero or one were considered to be consistent with =90% stenosis.[11] Two different independent observers analyzed the data without knowing the history of patient. All this protocol was duly approved by the ethical committee of the institute.

Statistical analysis was done by using statistical package for social sciences (SPSS) version 13. Spearman correlation test was used to see the correlation of two variables; perfusion and wall motion/thickness as it was an ordinal data.

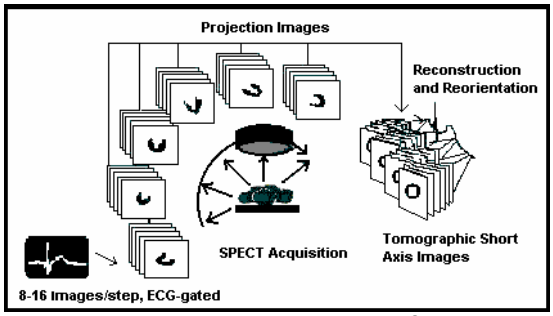
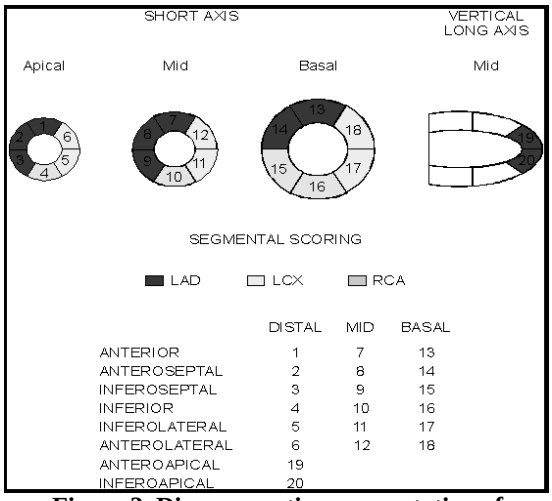


Figure 1. Schematic representation of ECG-gated SPECT acquisition and processing



	DISTAL	MID	BASAL
ANTERIOR	1	7	13
ANTEROSEPTAL	2	8	14
INFEROSEPTAL	3	9	15
INFERIOR	4	10	16
INFEROLATERAL	5	11	17
ANTEROLATERAL	6	12	18
ANTEROAPICAL	19		
INFEROAPICAL	20		

Figure 2. Diagrammatic representation of segmental division of SPECT slices with assignment of individual segments to individual coronary arteries

(LAD = Left anterior descending coronary artery; LCx = left circumflex coronary artery; RCA = right coronary artery).

RESULTS

Results showed good correlation between perfusion and W/M/T status. Out of 76 scans, 30% were normal, 22% transmural infarct, 25% partial thickness infarct, and 22% reversible ischemia. By doing 20 segmental analyses, total 1520 segments were analyzed which revealed good concordance of perfusion with W/M/T in 78% of segments and poor concordance in 22% of the segments (Figure 3). Out

of these 22%, 12% were having more wall motion abnormalities than that of perfusion, while in 10%, it was vice versa (Figure 4). Most common reason of more wall motion abnormalities than that of perfusion is cardiomyopathy and stunning. However, segments having more perfusion abnormalities than that of wall motion are usually because of attenuation artifacts which are usually seen in inferior wall.

Most of the patients referred to IRNUM were having chest pain (67%). However, patients having infarction (13%) or gone through Percutaneous Transmural Coronary Angioplasty (PTCA) or Coronary Artery Bypass Grafting (CABG) were also referred for evaluation of their cardiac perfusion status. (Figure 5) In risk factors analysis; hypertension, positive family history of IHD and obesity were the common one. (Figure 6) Statistical analysis done by SPSS showed a good correlation between gated and ungated data (r = 0.73) which is highly significant at confidence interval of 95% (p<0.01).

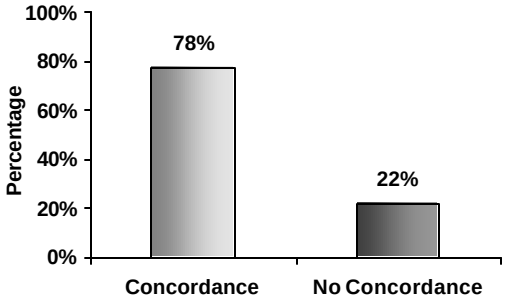
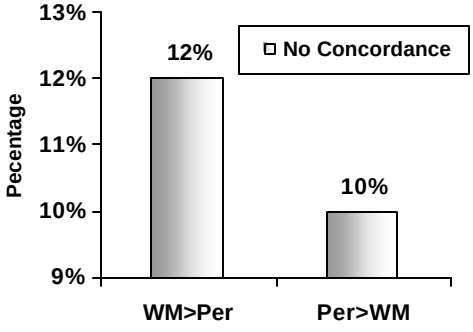


Figure 3. Graph representing the correlation of perfusion with wall motion/thickening (W/M/T)



status of left ventricle (r = 0.73, p=0.01)

Figure 4. Graph showing the segmental analysis in non-concordant myocardial segments
(Per = perfusion defects, WM = wall motion abnormalities).

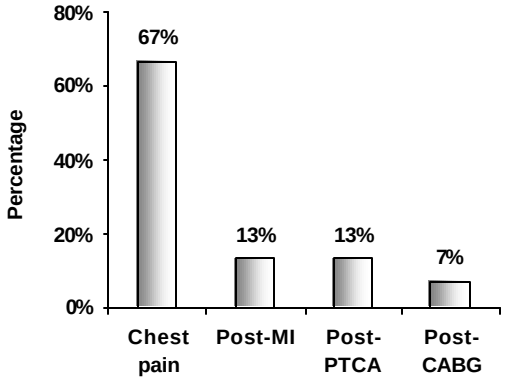


Figure 5. Symptomatic analysis of patients referred for the scan
[MI: Myocardial Infarction, PTCA: Percutaneous Transmural Coronary Angioplasty, CABG: Coronary Artery Bypass Grafting]

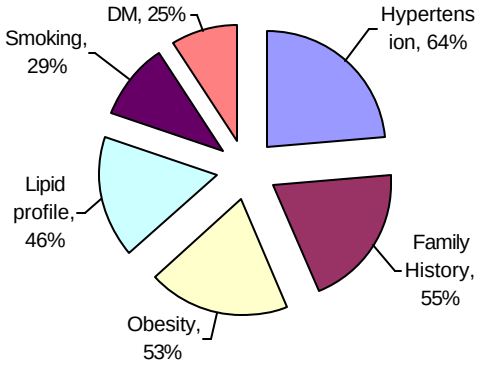


Figure 6. Analysis of risk factors in patients referred for the cardiac scan.

DISCUSSION

Detection of only perfusion without W/M/T may mislead a physician towards unnecessary intervention. It is now recommended that patient having mild to moderate reversible ischemia with good LV function should be followed with aggressive medical treatment.[3] However; if LV function is also compromised then one should go for angiography. Similarly, patient having severe perfusion defects with markedly compromised LV function is a candidate for immediate catheterization. Ungated SPECT helps in detection of only perfusion defects, which is incomplete information for further management of the patient. Therefore, ungated SPECT has been combined with gated SPECT to detect both perfusion as well as wall motion status of LV. New gamma cameras provide such facility that both of these scan can be performed in a one go. In this study, an attempt was made to correlate the results of gated with ungated SPECT in detection of

LV dysfunction. Most of the time, lesions correlate well as has been noted in this study (78%) but some time, exact correlation may not be there. There may be either more perfusion or wall motion abnormalities. More wall motion abnormality with good perfusion status is usually due to cardiomyopathy. However, possibility of stunned and hibernating myocardium should also be kept in mind. If the situation is reverse, mean perfusion abnormalities are more as compared to wall motion then attenuation artifacts, partial thickness infarct or reversible ischemia should be sorted out. In routine practice, usually echocardiography is performed to evaluate the W/M/T status of LV. However, many investigators have reported now the comparable accuracy of gated SPECT with echocardiography especially in evaluation of myocardial viability. [12-15]

Detection of viable myocardium before any intervention usually saves the patient from unnecessary surgery. Stunned myocardium, which results after acute insult of perfusion do not require any intervention. However, hibernating myocardium require surgery (CABG/PTCA) as it results after prolong ischemia and may lead to marked contractile dysfunction. Gated SPECT helps in detection of both these abnormalities especially when combined with nitrate augmentation.[16-18]

CONCLUSION

Results of this study shows good correlation between gated and ungated SPECT for evaluation of left ventricular dysfunction.

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