

Patient Trends of Stress Myocardial Perfusion Imaging: Experience in a Tertiary Center of Bangladesh

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ABSTRACT

Objectives: This retrospective study was performed to show population trends of gated stress myocardial perfusion imaging (MPI) using single photon emission computed tomography (SPECT) describing sociodemographic and clinical variables of the patients in a tertiary center, the National Institute of Cardiovascular Disease (NICVD).

Patients and Methods: This retrospective study recruited a total of 1236 patients who underwent stress-gated SPECT MPI scans from October 2019 to October 2024 in the department of Nuclear Cardiology, NICVD, Bangladesh.

Results: A total of 1236 patients were studied, with the majority of them being male (85.4%). Mean age in both genders is 52.2 years. The highest number of patients was found in the year 2023. Either pharmacological or exercise stress was given. The main indication of referral was risk stratification after old myocardial infarction (OMI) (65.2%). Major MPI findings in studied patients were fixed defect (68.7%); SVD (41.7%); DVD (32%); TVD (17.4%); high SSS in 77.3%. High-risk features found after ECG gating were a dilated left ventricular cavity (54.9%) and high TID (38.2%). Involved vascular territory in both coronary angiogram and MPI matched in 70% of cases.

Conclusion: Gated stress SPECT MPI is a powerful tool for risk stratification and management of CAD patients, and the Nuclear Cardiology department of NICVD is serving the Bangladeshi population on a wide scale in this regard.

Keywords: Myocardial perfusion imaging, single photon emission computed tomography, stress, high risk, ECG gating

Bangladesh J. Nucl. Med. Vol. 28 No. 2 July 2025

DOI: <https://doi.org/10.3329/bjnm.v28i1.79474>

INTRODUCTION

Since its introduction in 1971, radionuclide myocardial perfusion imaging (MPI) has revolutionized the assessment of patients with suspected or confirmed coronary artery disease (CAD) within the last 50 years. In order to diagnose, predict risk, and treat CAD, MPI has become essential to quantify the burden of myocardial

ischemia and scarring. The measurement of the degree and severity of reversible and irreversible perfusion defects has been essential in identifying obstructive coronary artery disease (CAD) and defining the ischemic and scar burden, which serve as the foundation for clinical judgments about the possible necessity of coronary angiography and revascularization. One known advantage of radionuclide MPI is its strong prognostic value, which serves as the foundation for its broad application and therapeutic relevance and enables precise risk-based management of CAD (1).

The gold standard for diagnosing epicardial CAD is still invasive coronary angiography (ICA). But a sizable fraction of individuals who are sent for coronary angiography turn out to be free of serious obstructive coronary disease (2). When the pretest probability of substantial CAD is less than 75%, ICA is not a cost-effective first-line investigative technique (3). It is also commonly known that there may not be a perfect correlation between the severity of anatomical stenosis and physiological severity (4). The importance of functional imaging has been highlighted in both the American and European guidelines for patients with an intermediate pretest risk of CAD (5, 6).

The purpose of our study is to provide information regarding the current state of nuclear cardiology in a tertiary center of Bangladesh. Demographic as well as clinical characteristics are highlighted to describe population trends that have done stress-gated SPECT MPI scans over a period of five years.

PATIENTS AND METHODS

The study recruited all adult patients who underwent gated stress SPECT MPI scans from October 2019 to October 2024,

expanding a period of five years in the Department of Nuclear Cardiology, National Institute of Cardiovascular Diseases (NICVD), Bangladesh. Ethical approval was acquired before commencing the study. The data were gathered from all scans conducted on one SPECT scanner, the CorCam™ Gamma Camera System from DDD-Diagnostic (originator country Denmark). SPECT MPI scans were performed for this study using a one-day stress/rest protocol using the technetium-99m (^{99m}Tc-Sestamibi) radiopharmaceutical. Both pharmacological and exercise stress were performed according to appropriateness. All image acquisition and processing were carried out in accordance with the American Society of Nuclear Cardiology (ASNC) SPECT Imaging Guidelines 2018 and by software Oasis by Segami Corporation and analyzed using Corridor-4DM v2015 software by INVIA medical imaging solutions. A retrospective data collection approach was implemented to collect all the required information for this study. Four nuclear medicine (NM) technologists were assigned to collect all the data used in this study. Collected data were properly evaluated by two senior cardiologists with more than fifteen years of experience and one nuclear medicine physician with more than six years of experience in their respective fields of expertise. Regarding the statistical data analysis, all the collected data were transferred to an Excel sheet. Then, after data entry, they were transferred to SPSS software version 25 from IBM Corporation and analyzed statistically. Data were expressed in frequency, percentage, mean, and standard deviation as appropriate.

RESULTS

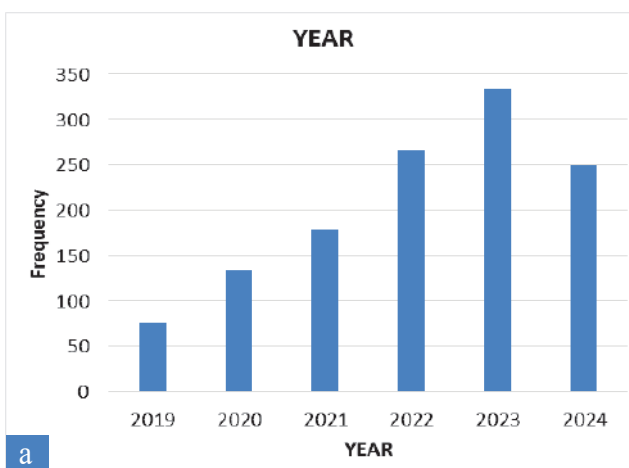
Accumulated data of total 1236 patients were evaluated. Among them, 85.4% (n=1055) of patients were male, and only 14.6% (n=181) of patients were female (Table 1). The mean age in both genders who were referred for MPI after a known cardiovascular event is around 52 years (Table 1), with the majority of the patients from both gender groups belonging to the 41 to 60 years age group (Figure 1b). Year-wise patient distribution showed that referral of patients gradually increased from 2019, with the highest number of MPIs performed in the year 2023 (n=333) (Figure 1a). Either pharmacological or exercise stress (54.4%) was given to all patients according to appropriateness, and adenosine was the only drug used for pharmacological stress (Table 1).

Table 1: Sociodemographic and clinical characteristics of the study patients

Mean Age (in years) ± standard deviation	52.3 ± 9.8 (male) 52.2 ± 11.2 (female)
Male gender	85.4% (n=1055)
Female gender	14.6% (n=181)
History of tobacco/smoking	
Current smoker	19.4% (n=240)
Ex smoker	41.7% (n=516)
Non smoker	38.8% (n=480)
Patients with history of DM	46.8% (n=579)
Patients with H/O hypertension (HTN)	45.1% (n=557)
Family history of cardiovascular disease	
Positive	92.6% (n=1145)
Negative	7.4% (n=91)
CAG	
Done	54.5% (n=674)
Not done	45.5% (n=562)
Type of stress given	
Adenosine	45.6% (n=563)
Exercise stress	54.4% (n=673)
Diagnosis on referral	
AMI/RMI	9% (n=111)
OMI	65.2% (n=806)
NSTEMI	7.1% (n=88)
IHD	2.8% (n=34)
CCS_UA	3.6% (n=45)
Post PCI	0.1% (n=1)
Others	12.2 (n=151)

Data were expressed as frequency(n) and percentage(%); DM=Diabetes Mellitus; AMI=Acute myocardial infarction;RMI=Recent MI;OMI=Old MI; IHD=Ischemic heart disease;STEMI=ST elevated MI; NSTEMI=Non STEMI; CCS=Chronic coronary syndrome;UA=Unstable angina.

Majority of the studied patients had positive history of smoking with non-smoker found about 38.8% . Hypertensive and diabetic patients made less than half of the studied population. But positive family history of cardiovascular diseases were found in nearly 93 % studied subjects (Table 1).



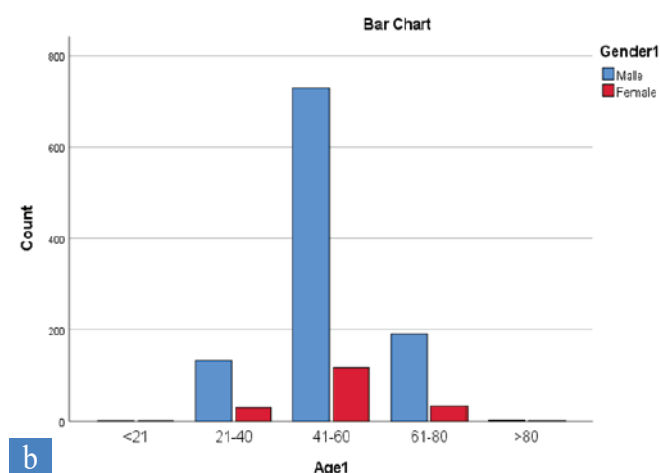


Figure-1: (a) Demographic distribution of studied stress SPECT MPI patients according to year from 2019 to 2024; (b) Age and Gender wise distribution of studied patients from the year 2019 to 2024

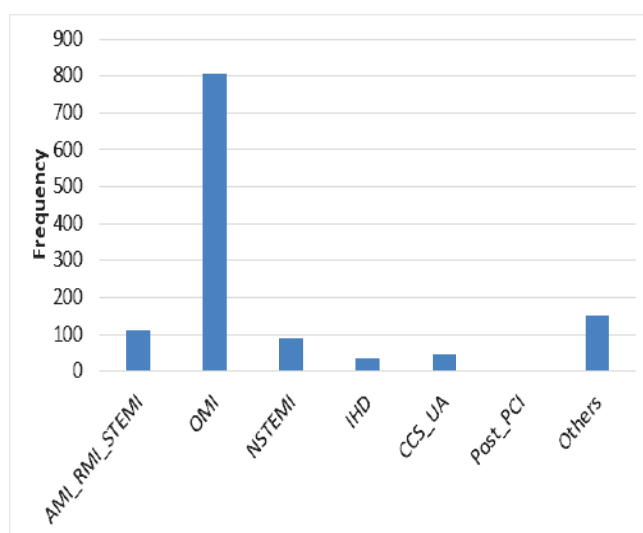


Figure 2: Frequency distribution of referred patients for stress SPECT MPI according to clinical indications

Referral pattern showed that mostly patients with old myocardial infarction (OMI) were referred for stress SPECT MPI imaging (n=806). Other indications for referral were acute MI (AMI), recent MI (RMI), non-ST-elevated MI (NSTEMI), ischemic heart disease (IHD), chronic coronary syndrome (CCS), unstable angina (UA), post-stenting/post-PCI, left bundle branch block (LBBB), cardiomyopathy, etc. (Table 1) (Figure 2). NICVD was the

referral institute in nearly all of these patients, with a minority being referred from private consultants. Nearly half (45.5%) of study patients were referred for stress SPECT MPI as the first-line investigation without performing any coronary angiogram (CAG) previously.

Table 2: Stress SPECT MPI findings including gating parameters and high risk features found in studied patients

Stress SPECT MPI findings	Frequency (n)	Percentage (%)
Type of perfusion defect		
• Fixed Defect	849	68.7
• Reversible defect	276	22.3
• No perfusion defect	111	09
Type of vascular territory involvement		
• Single vessel territory	336	27.2
➤ LAD territory	71	5.7
➤ LCX territory	109	8.8
➤ RCA territory	396	32
• DVD involved	215	17.4
• TVD involved		
Summed stress score (SSS) category		
• <9	188	15.2
• 9-13	91	7.4
• >13	956	77.3
Summed differential Score (SDS) category		
• <5	906	73.3
• ≥5	329	26.6
Dilated Left ventricular cavity	679	54.9
≥120 ml End diastolic volume (EDV) at stress	673	54.4
≥120 ml End diastolic volume (EDV) at rest	620	50.2
High TID value (Cut off <1.1)	472	38.2
Correlation between coronary angiogram and perfusion defect found in SPECT MPI		
• Matched defects	474	38.3
• Mismatched defect	200	16.2
• No previous CAG done	562	45.5

LAD=Left anterior descending artery; RCA=Right coronary artery; LCX=Left circumflex artery; TID=Transient ischemic dilatation; DVD=Double vessel disease; TVD=Triple vessel disease

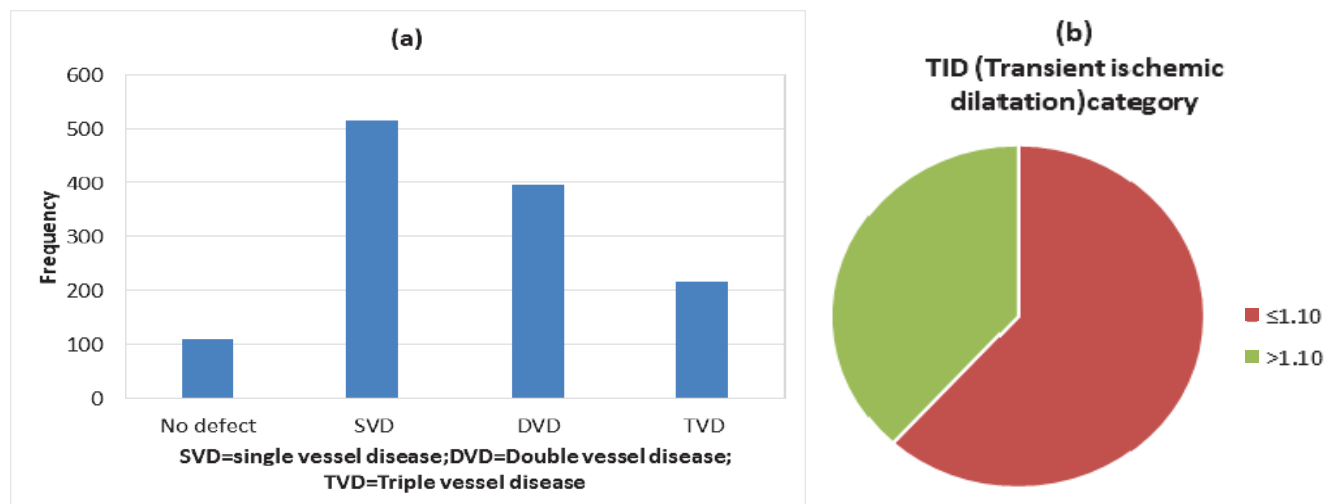


Figure-3: a) Frequency distribution of patients according to vascular territory involvement on stress SPECT MPI in studied patients; b) Pie chart showing studied patients with high and normal TID on Gated stress SPECT MPI

Stress SPECT MPI data of the studied population were further analyzed to describe the findings and high-risk features indicative of death from cardiac causes. Table 2 and figure 3(a) showed that the majority of the patients had fixed perfusion defects (68.7%) with mostly involvement of a single vessel territory of either LAD (27.2%), LCX (5.7%), or RCA (8.8%). A significant number of patients had also DVD and TVD, with no perfusion defect found in only 9% of the studied patients. Maximum patients had high SSS and low SDS values.

Gating parameters were also analyzed to show further high-risk features like dilated left ventricular cavity with low ejection fraction with high EDV at stress and at rest, high TID value, etc., and these are also present in a significant number of studied patients (Table 2) (Figure 3b). Finally, correlating the perfusion defect found in 674 studied patients who came after performing CAG with that of the perfusion defect found in stress SPECT MPI imaging were compared. Perfusion defects found in similar vascular territory to CAG in 474 among them.

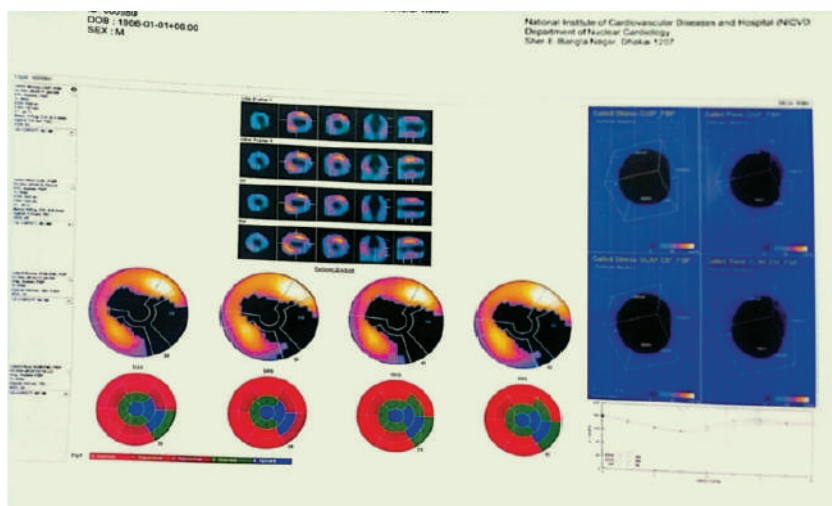


Figure 4: Sample image of ECG Gated SPECT MPI after exercise stress using a 17 segment distribution of left ventricular cavity showing three vascular territory of a 58 years old ex-smoker, hypertensive male with H/O NSTEMI, IHD, COPD and left ventricular failure. Image shows fixed perfusion defect in both LAD and LCX territory along with high SSS insignificant SDS indicating no survival benefit after revascularization. Left side of the image shows gating data like ejection fraction, EDV etc.

DISCUSSION

This retrospective analysis was performed to describe the patient trends of referral for SPECT MPI in the department of Nuclear Cardiology of NICVD as well as to describe demographic and clinical characteristics of the studied patients. Though the Nuclear Cardiology department of NICVD was established many years before, we have accumulated data for this study from a single machine after the establishment of the new SPECT scanner, CorCam™ Gamma Camera System from DDD-Diagnostic.

The mean age of our study patients with cardiovascular disease found was approximately 52 years, and the age range where maximum patients were found was between 41-60 years, which are similar in both sexes. These patients are all Bangladeshi. The study also showed a similar fact, stating that in comparison to other ethnic groups, South Asians are more likely to experience more severe CAD at a younger age (median age 53.0), and the cardiovascular event rate is comparable for both sexes in them in the younger age group (7).

A combination of hereditary and environmental variables probably plays a role in the pathophysiology of CAD. The "classic" risk factors—such as smoking, diabetes mellitus, or hypertension—play a significant role, as well as some unknown factors. The high incidence of CAD in Bangladesh may be explained by these factors alone or in various combinations within a genetically predisposed population (8). Studied patients data also corresponded, as a significant number of our study patients were either hypertensive or diabetic, with a history of smoking present in more than half of the population. The most notable fact is that 92.6% of them had a positive family history of cardiovascular events, which further strengthens the role of genetic predisposition.

Following an AMI, stress MPI is used in patient management and risk assessment, which is a main indication of stress SPECT MPI. Prior to hospital discharge, post-MI patients are frequently examined in some medical facilities. While treadmill stress MPI can be performed three months after AMI and, in cases of older MI, on the contrary, pharmacological stress perfusion is completed within three months of AMI in significant

situations. (9) Referral indications of the study population revealed that the majority of the patients came with a diagnosis of old MI. Also, RMI, AMI, and NSTEMI formed significant referral indications.

Data was analyzed according to high-risk features of SPECT MPI, like multivessel disease, high SSS, dilated LV cavity, high EDV at stress and at rest, high TID, etc. It was found that the majority of studied patients had high-risk features or fell into the high-risk category. According to Di Carli (2023), its strong predictive value, which enables precise risk-based treatment of CAD and serves as the foundation for its extensive use and therapeutic utility, is one of radionuclide SPECT MPI's acknowledged strengths. Major predictors of prognosis in patients with CAD are easily accessible from gated MPI, which underpins the use of SPECT MPI for risk stratification. These consist of the left ventricular dimensions and ejection fraction, the degree of myocardial ischemia and scarring, etc. Optimal risk stratification is based on the concept that the risk associated with normal study results is sufficiently low that referral to revascularization will not further improve patient outcomes. Hence, catheterization is an unlikely option after testing. Conversely, patients with severely abnormal stress imaging results are at greater risk of adverse events and, thus, are potential candidates for intervention, and the magnitude of their risk is related to the extent and severity of the imaging abnormalities. The effectiveness of radionuclide MPI for risk stratification has been demonstrated for nearly all patient subsets (1).

Many of the studied patients also referred for stress SPECT MPI without previous CAG. To determine the sensitivity and specificity of MPI in identifying CAD with reference to echocardiography only without CAG, two meta-analyses comprising 6972 patients were carried out. The results showed that the sensitivity and specificity were $\geq 87\%$ and $\geq 73\%$, respectively (11). However, in another study, for 96 patients, MPI's sensitivity and specificity in relation to CAG were 95% and 83%, respectively (12). In this study, CAG detected and stress MPI detected perfusion defects found similar in 70% ($n=474$ out of 674) of the population who had undergone both CAG and MPI.

CONCLUSION

This is the first study regarding demographics of MPI which included a very big number of study patients in a tertiary center of Bangladesh. It will help in future research studies. Stress Gated SPECT MPI is one of the powerful tool for CAD patients management as it plays both diagnostic and prognostic role by addressing high risk features for future cardiac events or cardiac death. As it is a non invasive tool, that's why cardiologists prefers this nuclear imaging modality for patients with heart failure or cardiomyopathy (indicated by dilated left ventricle with low ejection fraction) for identifying ischemia as the causative factor. Department of Nuclear Cardiology of NICVD is providing service to significant number of patients in a very affordable cost. This study additionally highlighted one demographic fact that familial predisposition for CAD needs to be widely evaluated for Bangladeshi population. Also it creates scope for further study regarding concordance between CAG and MPI findings.

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