Gated SPECT Myocardial Perfusion Imaging in female patients - an observational study

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ABSTRACT

Background: It had been a general observation that the number of female patients undergoing SPECT myocardial perfusion imaging (MPI) is lower per week.This study was done to find out their proportionand association among their symptoms, history of (h/o) acute coronary syndrome (ACS) and corresponding myocardial perfusion.

*Patients and methods:*This cross sectional retrospective study was conducted in 2017 on a group of patients who underwent gated SPECT myocardial perfusion imaging (GSMPI)from February 2005 to October 2016. Clinical record files and image files of all female patients were selected for analysis. The symptoms were retrospectively categorized according to New York Heart Association (NYHA) class while the patients were categorized according to their h/o ACS and myocardial perfusion in each patient was categorized as normal or perfusion defect. Data were analyzed using SPSS v.20.

*Results:*Among 1347 patients undergoing GSMPI 196 (14.6%) were female with a 4.4-fold increase in number over 12 years. Mean age was 51.8 ± 10.1 (27-80). Symptom categorization assigned 84 patients in NYHA class I and 112 in NYHA class II. There was no h/o ACS in 143 while 53 had a previous h/o hospitalization due to ACS. GSMPI revealed normal perfusion in 156 patients with mean left ventricular ejection fraction (LVEF) of 66.6 ± 13.6. Perfusion defect was present in 40 patients with mean LVEF of 45.5 ± 15.8. NYHA class of symptoms was not associated with perfusion status (p > 0.05).H/o ACS was found to have association both with NYHA class of symptoms and with perfusions status (p < 0.05).

Conclusions: Proportion of female patients undergoing GSMPI is low. Presence of perfusion defect in female was not associated with NYHA class of symptom.

Key words: **Myocardial perfusion imaging, gated SPECT, female, perfusion defect, LVEF, symptom.**

INTRODUCTION

Ischemic heart disease (IHD) in women has unique manifestations of symptoms, distribution of prevalence and, complex underlying pathophysiology (1). With an increasedrisk of obstructive coronary artery disease (CAD) in women, hospitalization with ST-segment elevation acute coronary syndrome (ACS) have higher in-hospital mortality (1) as well as a poor peri-procedural outcome (2). This warrants a smart use of screening and diagnostic tools for better prevention and efficient treatment of cardiovascular disease (CVD) in women (3).

While the CVD prevalence is on a steady rise for the last four decades, both genders are being equally affected by the disease (4). Gated SPECT myocardial perfusion imaging (GSMPI) has been aiding the management of CAD for the past two decades in Bangladesh (5). It has been generally observed that the proportion of females is relatively lower per week among the patients undergoing GSMPI at the National Institute of Nuclear Medicine & Allied Sciences (NINMAS). This study was done first, to find out their proportion over the past years and then, to find an association among their presenting symptom categorized as the New York Heart Association (NYHA) class, history of h/o acute coronary syndrome (ACS), and corresponding myocardial perfusion status.

PATIENTS AND METHODS

This cross sectional retrospective study was conducted in 2017. Study population was a group of patients who were referred to Nuclear Cardiology Division of NINMAS from February 2005 to October 2016 for GSMPI. Clinical record files and image files of all female patients were selected from the divisional archivefor the purpose of reviewing and inclusion in the study. All relevant demographic and clinical data were documented. Presenting symptom of each patient were retrospectively categorized according to NYHA class. Patients were further categorized in to two groups

according to their h/o ACS. Then perfusion was categorized as normal perfusion and perfusion defect which comprised ischemia, infarction and a combination of both. Data were analyzed using SPSS v.20. Continuous data were presented as means and standard deviations (SD) and value ranges. Categorical data were presented as frequencies and percentages. Chi square test of association was done where a p-value of < 0.05 was considered to be significant.

RESULTS

During the time span of 608 weeks, total 1347 patients underwent GSMPI at NINMAS. Among them 196 (14.6%) were female with a mean age of 51.8 ± 10.1 (27-80) years. Figure 1 shows a 4.4-fold increase in the

number of female patients undergoing GSMPI at NINMAS over the study period. Table 1 shows clinical characteristics among the study patients.
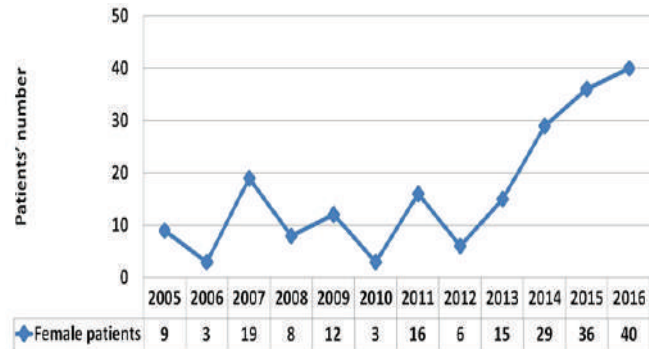

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Female patients	9	3	19	8	12	3	16	6	15	29	36	40

Figure 1: Temporal change in the number of female patients undergoing GSMPI per year at NINMAS over a period of 12 years
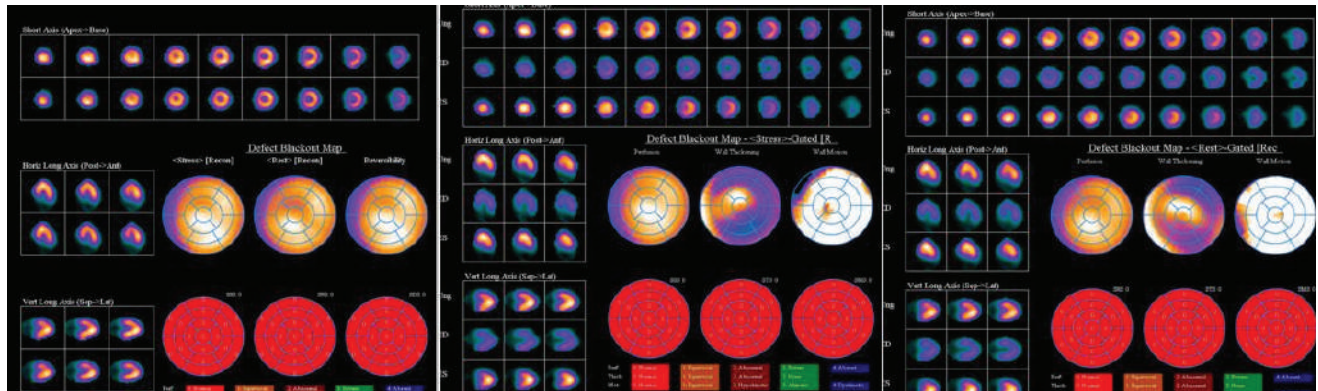

Figure 2: Representative case of NYHA class II symptom but non-obstructive CAD. Post stress and rest GSMPI images in a 45 years old female with history of hospital management as a case of ACS with normal rest ECG, echocardiogram &troponin I level; being unable to undergo exercise ECG, underwent pharmacological stress GSMPI to reveal normal myocardial perfusion with normal global wall motion and thickening with LVEF >60%
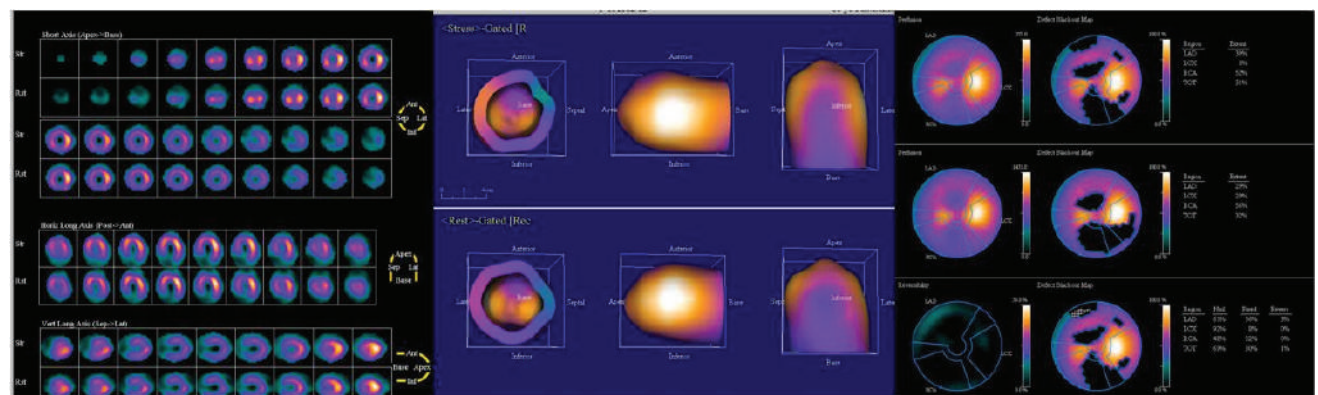

Figure 3: Representative case of NYHA class I symptom with microvascular dysfunction. Post stress and rest GSMPI images in a 55 years old female. With >10 years'history of uncontrolled diabetes mellitus, she was found to have inferior wall hypokinesia and LVEF of 40% during an echocardiogram as a part of routine check-up; being unable to undergo exercise ECG, underwent pharmacological stress GSMPI to reveal fixed perfusion defects over triple vessel's territory affecting 30% of total myocardium. EDV and EF were 156 ml and 45% at stress and 133 ml and 37% at rest.

GSMPI revealed normal perfusion in 156 patients. As shown in figure 2, a representative post stress and rest GSMPI images of a 45 years old female who with a history of hospital management as a case of acute coronary syndrome and rest ECG, echocardiogram and troponin I all within normal limits, being unable to undergo exercise ECG, underwent pharmacological stress GSMPI to reveal normal myocardial perfusion with normal global wall motion and thickening with LVEF >60%. Perfusion defect, comprising of ischemia or infarction or both together were seen in 40 patients.

Figure 3 shows a representative post stress and rest GSMPI images in a 55 years old female. With >10 years history of uncontrolled diabetes mellitus, she was found to have inferior wall hypokinesia and LVEF of 40% during an echocardiogram as a part of routine check-up; being unable to undergo exercise ECG, underwent pharmacological stress GSMPI to reveal fixed perfusion defects over triple vessels territory affecting 30% of total myocardium. EDV and EF were 156 ml and 45% at stress and 133 ml and 37% at rest.

Table 1: Clinical characteristics among the study patients

Traits	Frequency	Age	GSMPI LVEF at rest	GSMPI LVEF at stress
Coronary Angiogram				
Triple vessel disease	18	55.2±10.1	52.3±19.2	52.7±17.9
Double vessel disease	14	58.4±8.9	55.2±18.2	56.6±14.5
Single vessel disease	29	48.9±10.3	54.4±15.7	57.8±20.5
Normal	12	47.1±13.1	67.3±12.3	68.1±10.3
Not done	123	51.8±9.4	65.7±15.2	68.9±14.9
Previous Coronary Revascularization				
Thrombolysis	03	53.3±13.6	46.0±22.7	38.3±21.4
Cardiac surgery	10	56.7±9.3	59.3±10.4	58.5±13.2
Angioplasty	15	55.8±9.1	60.4±19.1	67.0±17.8
Severe LV dysfunction on GSMPI				
LVEF < 40% EDV > 140	11	54.3±13.4	26.7±7.9	28.9±5.7
Reduced LVEF at stress	04	56.8±7.1	30.5±6.9	24.3±4.9
Dilated LV at stress	04	60.0±8.5	23.3±7.2	26.8±5.9
Stress category				
Dobutamine stress echo	84 (positive in nine)	52.6±10.2	62.1±17.2	63.6±17.9
Exercise treadmill	41 (positive in 12)	50.2±8.1	67.5±10	70.8±9.9
Adenosine stress	60	50.5±11.4	61.3±14.7	63.1±17.5
Rest MPI	11	52.7±12.1	43.1±18.9	-
Symptom category				
NYHA class I	84	51.3±10.3	60.1±15.5	62.5±15.9
NYHA class II	112	52.3±9.9	63.7±17.2	66.9±17.0
H/o ACS				
No h/o ACS	143	51.5±9.6	65.7±14.4	68.8±14.7
With h/o ACS	53	52.8±11.1	52.3±18.2	53.5±17.4
Perfusion category				
Normal Perfusion	156	51.7±9.6	66.6±13.6	69.9±13.5
Abnormal Perfusion	40	52.3±11.8	45.5±15.8	44.9±13.4

Among the 156 patients with normal perfusion, the mean left ventricular ejection fraction (LVEF) was 66.6 ± 11.2 and 66 had NYHA class I symptom while 90 had NYHA class II symptom (Table 2). Perfusion defect was present in 40 patients with mean LVEF of 45.5 ± 15.7, of them 18 had NYHA class I symptom and 22 had NYHA class II symptom (Table 2). The Pearson Chi-square value for association between symptom class versus perfusion status is 0.094 with the two-sided asymptotic p-value being 0.76.

Table 2: Distribution of NYHA class of symptomsaccording to perfusion status

	Normal perfusion	Abnormal perfusion
NYHA class I	66	18
NYHA class II	90	22

Among the 53 patients with previous H/O ACS, 29 had NYHA class I symptoms and 24 had NYHA class II symptoms (Table 3). The Pearson Chi-square value for association between symptom class versus H/O ACS is 4.17 with the two-sided asymptotic p-value being 0.04.

Table 3: Distribution of NYHA class of symptoms according to h/o ACS

	No H/O ACS	H/O ACS
NYHA class I	55	29
NYHA class II	88	24

Total 18 (9%) patients had reversible perfusion defect on scan (no previous H/O ACS) and 31 (~16%) patients despite a previous H/O ACS had normal myocardial perfusion (Table 4).However, the Pearson Chi-square value of 19.9 with the two-sided asymptotic p-value being < 0.001indicates an association between perfusion status versus H/O ACS.

Table 4: Distribution of perfusion status according to history of ACS

	No H/O ACS	H/O ACS
Normal perfusion	125	31
Perfusion defect	18	22

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To sum up, the NYHA class of symptoms was not found to be associated with GSMPI derived perfusion status (p > 0.05) in this series of female patients. Additionally, the H/O ACS was found to have strong association both with NYHA class of symptoms and with GSMPI derived perfusions status (p < 0.05).

DISCUSSION

In this series, 14.6% was the proportion of female patients against the total patient pool undergoing GSMPI over 12 years, although with a 4.4-fold increase of the total number of patients in the year-2016, the last time point of data inclusion in comparison to year-2005, the point of the first set of data availability. The International Atomic Energy Agency Nuclear Cardiology Protocols Study Registry (6), which did not include data from Bangladesh, comprises GSMPI data from 7911 patients from 65 continents. Though the cumulated proportion of females in this study was 41% the actual proportion varied from <25% to ≥55% among the countries. However, the weighted pool prevalence for cardiovascular disease was the same 3% for both genders with a 0.12% per-year rise of prevalence over 39 years, in a recent meta-analysis of 13 studies comprising of 129,740 persons (4).

In this series, 31% of patients who were referred for GSMPI had significant coronary artery disease. In a recent series of patients undergoing diagnostic angiography in a tertiary hospital the reported proportion of normal coronary angiogram was 25% (7). The proportion of coronary revascularization was 14% with the proportion of severe LV dysfunction being 5.6% among all female patients who underwent GSMPI. The proportion of female patients was 3% in a series on coronary revascularization (8) and 4% in another series of severe LV dysfunction (5) in patients of both genders undergoing GSMPI.

The major proportion of patients underwent dobutamine stress echo in this series of symptomatic female patients, where 10.7% were found positive for inducible myocardial ischemia. Stress echocardiography is known to be of high diagnostic accuracy in women with chest pain (9) even if there is a low cardiovascular risk profile

(10) whereas its combination with GSMPI can aid decision for revascularization and prediction of prognosis (11). Among the patients undergoing exercise treadmill stress, 29% were found positive for inducible ischemia. A series from Bangladesh found the false positive rate for treadmill test in women to be 35% (12). A recent meta-analysis not only reconfirms the higher false positivity of treadmill stress in women but also assigns this attribute particularly to perimenopausal women (13), while compromised coronary perfusion in postmenopausal women may be reflected by a lower peak rate pressure product (14). Although the reduced exercise capacity in women can result from an underlying coronary microvascular dysfunction or a non-obstructive CAD(15), the Asian women reportedly have a mismatched prevalence of CAD with the risk factor derived pre-test probability (16). Adenosine stress was used in 30.6% of female patients as per clinical recommendation and was found to be generally well-tolerated and better accepted than the other two modalities, a fact that deserves another systematic investigation to be fitted in the routine clinical protocol.

This series fails to find an association between NYHA class of symptoms with myocardial perfusion status defined as normal or abnormal. This in turn supports the recommendation for using the 'Activities of Daily Living' or the 'Duke Activity Status Index' in combination with an 'IHD risk estimate' for evaluation of symptomatic women towards their candidacy for stress GSMPI.(17). Though there was a statistical association between the classes of symptoms and H/O ACS, the larger proportion of patients in both the class of symptoms had no previous H/O ACS. On the contrary, 9% of all the symptomatic patients were detected with new myocardial ischemia. Paradoxically, normal myocardial perfusion in ~16% despite receiving treatment for ACS indicates a non-obstructive CAD that is known to occur with a rate of 10-25% (1). Altogether our findings support the necessity of increasing the application of stress GSMPI in women because they, on the one end, can have more symptoms despite non-obstructive CADs, on the other end, can have a less symptomatic progression of microvascular dysfunction coexisting with metabolic disease (1,17).

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Moreover, stress SPECT imaging of myocardial perfusion is appropriate in an individual of any pretest probability if the ECG is uninterpretable or there is an inability to exercise (17).

CONCLUSION

Despite the proportion of female patients undergoing GSMPI has remained low, a temporal increase in the number of patients indicates increased acceptance of GSMPI by the clinicians and patients. We recommend that the application of pharmacological stress GSMPI should further increase among women.

DISCLOSURE

No competing financial interests exist

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