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ASSESSMENT OF ROUTINE STRESS-REST TC99M-MIBI MYOCARDIAL PERFUSION SCINTIGRAPHY FOR ATYPICAL ANGINA PATIENTS

Original Research

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ABSTRACT

Background: Myocardial perfusion scintigraphy (MPS) using technetium-99m sestamibi (Tc-99m MIBI) is a well-established non-invasive imaging technique for assessing myocardial ischemia and coronary artery disease (CAD). Atypical angina, presenting with non-classical symptoms such as epigastric discomfort, jaw or arm pain, and chest tightness, poses diagnostic challenges due to its intermediate risk for CAD. Identifying myocardial ischemia in these patients is crucial for early intervention and risk stratification. This study evaluates the diagnostic utility of routine stress-rest Tc-99m MIBI MPS in patients with atypical angina.

Objective: To assess the effectiveness of stress-rest Tc-99m MIBI myocardial perfusion scintigraphy in detecting myocardial ischemia and evaluating cardiac function in patients presenting with atypical angina.

Methods: This analytical cross-sectional study was conducted over four months at the Punjab Institute of Cardiology, Lahore. A total of 47 patients with atypical angina and inconclusive coronary angiography findings were included. Data on age, gender, medical history, heart rate, blood pressure, and Tc-99m MIBI doses were collected. Patients with contraindications to Tc-99m MIBI or stress testing were excluded. Heart rate and blood pressure were recorded at rest and under stress conditions. Statistical analysis was performed using descriptive methods.

Results: Among 47 participants, 68.1% were female. Age distribution was 12.8% in 30–40 years, 34.0% in 41–50 years, 34.0% in 51–60 years, and 19.1% in 61–70 years. Medical history showed 44.7% had no symptoms, 19.1% had palpitations, 14.9% were obese, 12.8% had shortness of breath, 6.4% had diabetes, and 2.1% were smokers. Resting heart rate was high (>85 bpm) in 70.2% of patients, increasing to 80.9% under stress. Hypertension Stage 2 was observed in 34.0% at rest and 83.0% under stress. Tc-99m MIBI doses ranged from 400–450 MBq in 61.7% of patients.

Conclusion: Tc-99m MIBI myocardial perfusion scintigraphy proves to be a valuable diagnostic tool in detecting ischemia and myocardial perfusion abnormalities in patients with atypical angina. Its use facilitates early diagnosis and effective management of CAD, particularly in cases where traditional diagnostic methods are inconclusive.

Keywords: Atypical angina, coronary artery disease, diagnostic imaging, myocardial ischemia, myocardial perfusion scintigraphy, nuclear medicine, technetium Tc-99m sestamibi.

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INTRODUCTION

Myocardial perfusion scintigraphy (MPS) is a widely used non-invasive imaging technique to assess coronary artery disease (CAD) by evaluating myocardial blood flow. This technique involves the administration of a radiopharmaceutical that accumulates in well-perfused cardiac tissue, allowing for the identification of areas with reduced blood supply indicative of ischemia (1,2). Among the available radiotracers, technetium-99m-sestamibi (Tc-99m MIBI) has demonstrated effectiveness in detecting inducible myocardial ischemia, offering superior imaging quality compared to earlier methods such as Thallium-201 scintigraphy, which was associated with higher radiation exposure and suboptimal image resolution (3). The accurate diagnosis of CAD remains a challenge, particularly in cases of atypical angina, where symptoms may not follow the classical presentation of exertional chest pain. Instead, patients with atypical angina often report epigastric discomfort, burning sensations, or pain extending to the jaw and arms, making clinical assessment more complex (4,5). Atypical angina poses a diagnostic dilemma as it carries an intermediate risk of CAD, particularly in women over 50 and men across all age groups. Compared to typical angina, which is more strongly associated with CAD, atypical symptoms complicate risk stratification and necessitate advanced diagnostic imaging to ensure early and accurate detection of myocardial ischemia (6). In primary care settings, approximately 1% of patient visits are due to angina, with 2% to 4% of these cases progressing to unstable angina or myocardial infarction, underscoring the need for effective diagnostic tools (7). In Pakistan, a considerable proportion of patients presenting with chest discomfort—up to 37%—are diagnosed with acute coronary syndrome (ACS), further emphasizing the importance of precise assessment methods (8). Various imaging modalities, including cardiac MRI, echocardiography, and nuclear techniques such as positron emission tomography (PET) and single-photon emission computed tomography (SPECT), provide valuable insights into myocardial perfusion and viability (9). Of these, SPECT imaging using Tc-99m MIBI is widely adopted due to its availability, reliability, and ability to differentiate ischemic from viable myocardial tissue. However, despite its advantages, Tc-99m MIBI may underestimate myocardial viability compared to PET, which offers superior resolution but is less accessible due to limited nuclear medicine facilities utilizing PET radiopharmaceuticals (10,11).

Standard nuclear cardiology protocols for stress-rest Tc-99m MIBI myocardial perfusion imaging recommend a minimum delay of 45 to 60 minutes between radiotracer injection and imaging for resting studies, 15 to 20 minutes for exercise stress tests, and 60 minutes for pharmacologic stress exams (12). Some centers implement a stress-only imaging (SFI) approach, omitting the rest phase when stress imaging results are normal, thereby reducing patient radiation exposure and examination time (13). In cases where patients are unable to perform treadmill exercise, pharmacologic stress tests using agents such as dobutamine or vasodilators are employed as alternatives (14). This study aims to assess the utility of routine stress-rest Tc-99m MIBI myocardial perfusion scintigraphy in patients presenting with atypical angina, evaluating its role in identifying myocardial ischemia and stratifying cardiac risk. Additionally, it seeks to enhance clinical decision-making by correlating imaging findings with clinical presentations, thereby facilitating timely and accurate diagnosis for improved patient outcomes.

METHODS

This analytical cross-sectional study was conducted at the Punjab Institute of Cardiology, Lahore, over a period of four months following the approval of the study protocol by the institutional review board. The required sample size was calculated using a standard statistical formula, yielding a minimum of 47 participants. A non-probability sampling technique was employed for participant selection. The study population comprised individuals presenting with atypical angina who met specific inclusion criteria. Eligible participants included those with a positive stress test on electrocardiography (ECG) and echocardiography, individuals with inconclusive or negative coronary angiography despite persistent angina symptoms, and patients undergoing Tc-99m MIBI myocardial perfusion scintigraphy for suspected coronary artery disease (CAD). Written informed consent was obtained from all participants before enrollment in the study. Patients were excluded if they had a documented allergy to contrast agents, uncontrolled heart failure, arrhythmias, contraindications to Tc-99m MIBI administration, severe renal impairment, uncontrolled diabetes, ongoing systemic infections, or any condition that precluded participation in stress testing. Data collection involved clinical assessment, medical history review, and imaging studies, including ECG, echocardiography, and myocardial perfusion scintigraphy. The stress-rest Tc-99m MIBI protocol was followed, with imaging performed as per established nuclear cardiology guidelines. Stress testing was conducted using either treadmill exercise or pharmacologic agents in cases where physical exertion was contraindicated.

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Imaging data were analyzed to assess myocardial perfusion abnormalities, and results were correlated with clinical findings to determine the diagnostic utility of Tc-99m MIBI in patients with atypical angina. Statistical analysis was performed using appropriate software, with categorical variables presented as frequencies and percentages, while continuous variables were analyzed using means and standard deviations. Ethical considerations were strictly adhered to, with approval obtained from the relevant ethical review committee, ensuring compliance with institutional and international research guidelines.

RESULTS

The study analyzed data from 47 patients, assessing age distribution, gender, medical history, coronary interventions, Tc-99m MIBI doses, heart rates, and blood pressure under resting and stress conditions. The age distribution showed that 12.8% of participants were aged 30–40 years, 34.0% were aged 41–50 years, 34.0% were aged 51–60 years, and 19.1% were aged 61–70 years. Gender analysis indicated that 68.1% of participants were female, while 31.9% were male. Medical history findings revealed that 44.7% of patients had no symptoms, 19.1% reported palpitations, 14.9% were obese, 12.8% experienced shortness of breath, 6.4% had diabetes, and 2.1% were smokers. Regarding coronary intervention, 72.3% of patients had no prior history of coronary procedures, while 27.7% had undergone at least one intervention. Tc-99m MIBI dose distribution showed that 61.7% of patients received a dose between 400 and 450 MBq, 27.7% received a dose between 450 and 500 MBq, and 10.6% received a dose above 500 MBq.

Resting heart rate analysis indicated that 25.5% of patients had a low heart rate (≤85 bpm), 70.2% had a high heart rate (>85 bpm), while data for 4.3% were unspecified. Under stress conditions, 19.1% had a low heart rate (≤85 bpm), while 80.9% exhibited a high heart rate (>85 bpm). Resting blood pressure assessment showed that 57.4% of participants had normal blood pressure (systolic ≤120 mmHg and diastolic ≤80 mmHg), 8.5% had Hypertension Stage 1 (systolic 130–139 mmHg or diastolic 80–89 mmHg), and 34.0% had Hypertension Stage 2 (systolic ≥140 mmHg or diastolic ≥90 mmHg). Under stress conditions, 17.0% of patients maintained normal blood pressure, while 83.0% had Hypertension Stage 2.

Table 1: Demographic Distribution of Patients

Demographic Variable	Frequency (%)
Age Group 30-40	6 (12.8%)
Age Group 41-50	16 (34.0%)
Age Group 51-60	16 (34.0%)
Age Group 61-70	9 (19.1%)
Female	32 (68.1%)
Male	15 (31.9%)

Table 2: Medical History and Coronary Intervention Status of Patients

Medical Condition / History	Frequency (%)
No Symptoms	21 (44.7%)
Palpitations	9 (19.1%)
Diabetes	3 (6.4%)
Obesity	7 (14.9%)
Smoking	1 (2.1%)
Shortness of Breath	6 (12.8%)
No History of Coronary Intervention	34 (72.3%)
History of Coronary Intervention	13 (27.7%)

Table 3: Tc-99m MIBI Dose, Heart Rate, and Blood Pressure Distribution Among Patients

Parameter	Frequency (%)
Tc-99m MIBI Dose 400–450 MBq	29 (61.7%)
Tc-99m MIBI Dose 450–500 MBq	13 (27.7%)
Tc-99m MIBI Dose Above 500 MBq	5 (10.6%)
Resting Heart Rate ≤ 85 bpm	12 (25.5%)
Resting Heart Rate > 85 bpm	33 (70.2%)
Resting Heart Rate Unspecified	2 (4.3%)
Stress Heart Rate ≤ 85 bpm	9 (19.1%)
Stress Heart Rate > 85 bpm	38 (80.9%)
Resting BP: Normal (≤120/≤80 mmHg)	27 (57.4%)
Resting BP: Hypertension Stage 1 (130–139/80–89 mmHg)	4 (8.5%)
Resting BP: Hypertension Stage 2 (≥140/≥90 mmHg)	16 (34.0%)
Stress BP: Normal (≤120/≤80 mmHg)	8 (17.0%)
Stress BP: Hypertension Stage 2 (≥140/≥90 mmHg)	39 (83.0%)

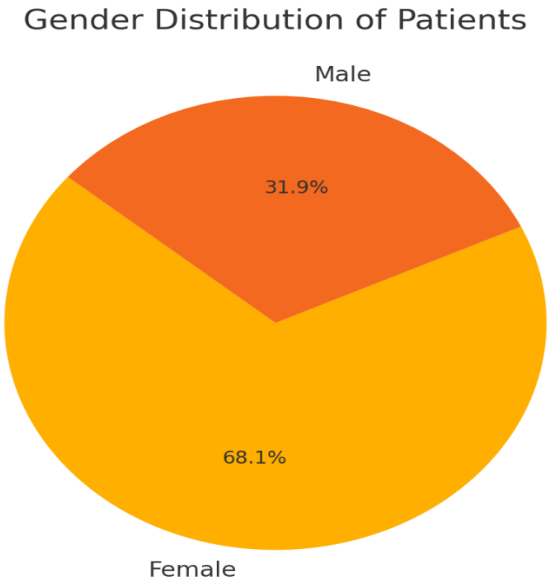

Figure 2 Gender Distribution of Patients

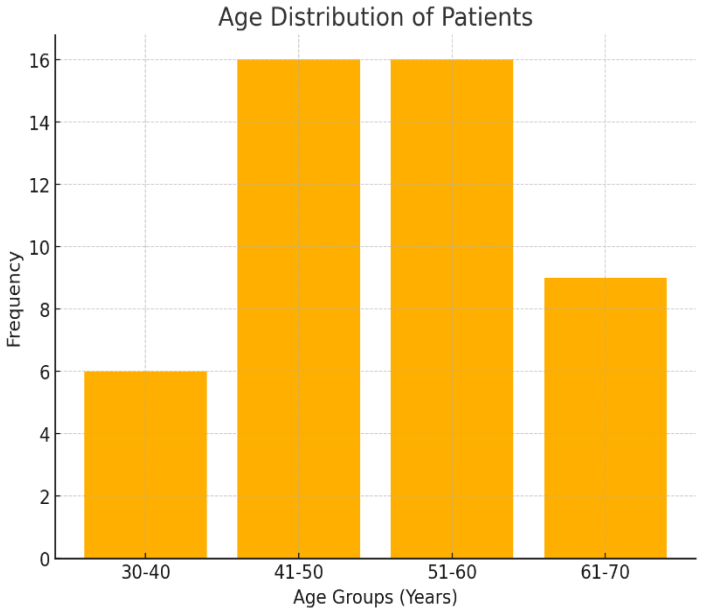

Figure 1 Age Distribution of Patients

DISCUSSION

Atypical angina is characterized by pain that occurs in the epigastric region or back, often accompanied by burning, stabbing sensations that may mimic indigestion. Common symptoms include discomfort in the chest, jaw, and arms, along with tightness around the chest cavity and dullness. Unlike typical angina, this condition does not follow a predictable pattern, making its diagnosis challenging (15). Cardiovascular diseases, including ischemic heart disease, disproportionately affect populations residing in rural regions, particularly in developing countries where access to advanced diagnostic facilities remains limited. In certain regions, a significant proportion of the

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population faces financial barriers to undergoing essential diagnostic tests such as ECG, CT scans, echocardiography, and angiography, further complicating early detection and management of ischemic heart disease (16,17). The role of myocardial perfusion scintigraphy (MPS) in diagnosing CAD in patients with atypical angina has been studied extensively, with varying results. One study reported abnormal perfusion defects in 36.1% of cases, while others found that up to 69% of patients exhibited positive exercise treadmill test (ETT) results, yet no consistent pattern was observed between MPI defects and exercise outcomes (18). Findings from the present study indicated that 38.3% of patients exhibited normal myocardial perfusion, whereas others had varying degrees of ischemia, emphasizing the role of MPS in identifying cardiac abnormalities even in patients with inconclusive stress test results.

Demographic data analysis demonstrated variations in age and gender distribution across different studies. Some investigations have shown that a significant proportion of ischemic heart disease cases occur in individuals over the age of 65 (19), while others have reported a mean patient age of approximately 41 years, with a predominance of female participants (20). The present study identified a similar female predominance, with 68.1% of participants being female and 31.9% male. This contrasts with other studies that reported a higher prevalence of ischemic heart disease in male patients (21). These findings highlight potential gender-based variations in the presentation of atypical angina and underscore the need for further research into sex-specific risk factors and diagnostic strategies. Studies have indicated that females experience higher rates of major adverse cardiac events (MACE) than males, reinforcing the importance of early and accurate diagnosis in this subgroup (22). Tc-99m MIBI dosage variations have been examined in relation to ischemia detection, with some studies suggesting that nitrate administration alongside radiotracer use may improve ischemia detection rates (1). The present study observed a Tc-99m MIBI dose range between 400 and 500 MBq, with the most common dose being 450 MBq, which aligns with established nuclear cardiology protocols. Medical history evaluation revealed that while some patients presented with comorbidities such as diabetes, obesity, and smoking history, a significant proportion (44.7%) had no reported symptoms. These findings contrast with studies that reported higher prevalence rates of conditions such as congestive heart failure and renal impairment in similar cohorts (19). The observed variation in comorbidities may be attributed to differences in study populations, underlying health conditions, and regional disparities in cardiovascular disease prevalence.

Obesity has been widely recognized as a contributing factor to both ischemic heart disease and associated symptoms such as breathlessness (23). The present study found that 14.9% of patients were obese, which is consistent with previous research linking obesity to an increased risk of ischemic events. The relationship between gender, cardiovascular risk factors, and ischemic disease progression remains complex. While some research indicates that premenopausal women exhibit a higher incidence of CAD compared to their postmenopausal counterparts, additional studies have suggested that diabetes and smokeless tobacco use are more prevalent among postmenopausal women (20). The present study found that 38.3% of patients had normal myocardial perfusion, while 21.3% had mild ischemia, 19.1% had moderate ischemia, 12.8% had severe ischemia, and 8.5% had CAD. These findings support existing evidence indicating that ischemic heart disease risk is influenced by multiple factors, including metabolic conditions and lifestyle habits. Coronary intervention history was documented in 27.7% of patients, which is comparable to studies reporting silent myocardial ischemia in approximately 22% of cases (24). This finding suggests that a considerable proportion of patients may present with ischemic heart disease without prior intervention, further emphasizing the importance of early detection and appropriate diagnostic modalities such as MPS. Heart rate analysis indicated that 70.2% of patients had a high resting heart rate (>85 bpm), and 80.9% had an elevated stress heart rate, findings that align with previous research associating increased heart rates with abnormal myocardial perfusion (25,26). Blood pressure analysis revealed that 34.0% of patients exhibited hypertension at rest, while 83.0% developed Hypertension Stage 2 under stress conditions. Prior studies have reported a higher frequency of abnormal MPI findings in patients with hypertension (27,28), further supporting the role of blood pressure as a key determinant of ischemic heart disease progression.

The present study is subject to several limitations, including a relatively small sample size and a single-center design, which may limit the generalizability of findings. Additionally, the lack of long-term follow-up prevents the assessment of prognostic outcomes and the impact of MPS findings on clinical management. Future research should focus on multicenter studies with larger sample sizes to validate these findings and explore the role of adjunctive imaging techniques such as PET in improving ischemia detection. Despite these limitations, the study provides valuable insights into the role of Tc-99m MIBI myocardial perfusion scintigraphy in patients with atypical angina, reinforcing its significance as a non-invasive tool for diagnosing and stratifying the risk of ischemic heart disease.

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CONCLUSION

This study evaluated the role of routine stress-rest Tc-99m MIBI myocardial perfusion scintigraphy in diagnosing and assessing myocardial function in patients with atypical angina. The findings demonstrated that many patients exhibited significant cardiovascular stress responses, including elevated heart rates and hypertensive changes during stress testing, underscoring the physiological burden of ischemic heart disease in this population. Additionally, the low rate of prior coronary interventions highlighted the need for effective non-invasive diagnostic tools in identifying myocardial perfusion abnormalities. The widespread use of Tc-99m MIBI scintigraphy proved valuable in detecting ischemic changes and assessing myocardial viability, reinforcing its significance in clinical decision-making for patients with atypical angina. These findings emphasize the importance of early and accurate evaluation of myocardial perfusion, which can contribute to better risk stratification and optimized management strategies for individuals at risk of ischemic heart disease.

AUTHOR CONTRIBUTIONS

Author	Contribution
Muhammad Muneeb Aslam	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Tahira Batool	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muhammad Jahanzaib	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Faqeeha Javed	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Qurba Kiran	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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