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PREVALENCE AND PREDICTORS OF SILENT MYOCARDIAL ISCHEMIA IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

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Abstract

Introduction: *Silent myocardial ischemia (SMI) is a clinically asymptomatic condition characterized by ischemic changes without anginal symptoms, commonly observed in patients with type 2 diabetes mellitus (T2DM). It contributes significantly to cardiovascular morbidity and mortality due to delayed diagnosis and treatment.*

Objective: *To determine the prevalence and predictors of silent myocardial ischemia among patients with type 2 diabetes mellitus at a tertiary care hospital in Peshawar.*

Methodology: *This cross-sectional study was conducted from January to September 2024 at the Lady Reading Hospital (LRH), Peshawar, in the Department of Cardiology. A total of 300 patients aged 35–70 years with T2DM were enrolled through consecutive sampling. Participants underwent a resting electrocardiogram (ECG) and treadmill exercise stress testing, while those unable to exercise underwent pharmacologic stress testing. SPSS version 26.0 was used to analyze the data, and logistic regression was used to find independent predictors of SMI.*

Results: *The prevalence of SMI was 27.7%. SMI was more common among males (60.2%), patients with hypertension (63.9%), and those with poor glycemic control (65.1 %) (HbA1c ≥ 8%). On multivariate analysis, poor glycemic control*

(AOR 2.78; p=0.002) and a longer duration of diabetes ≥10 years (AOR 2.41; p=0.008) were significant predictors of SMI.

Conclusion: *Silent myocardial ischemia is highly prevalent among patients with T2DM, particularly in those with prolonged disease duration and poor glycemic control. Regular cardiovascular screening and strict metabolic management are crucial for early detection and prevention of complications.*

Introduction

Cardiovascular disease is the leading cause of morbidity and mortality worldwide, with myocardial ischemia being a major contributor due to its subtle onset and severe complications [1]. Myocardial ischemia occurs when myocardial oxygen demand exceeds supply, usually because of coronary artery narrowing [2]. In some individuals, ischemic episodes occur without symptoms, a condition known as silent myocardial ischemia (SMI) [3]. Because SMI lacks warning signs like chest pain, it often goes undetected until complications such as myocardial infarction, heart failure, or sudden cardiac death occur [3].

Type 2 diabetes mellitus (T2DM) is a key risk factor for coronary artery disease and myocardial ischemia [4]. Chronic hyperglycemia leads to endothelial dysfunction, atherosclerosis, and autonomic neuropathy, which diminishes pain perception and explains the asymptomatic nature of SMI in many diabetic patients [5]. Studies show that individuals with diabetes are two to four times more likely to develop ischemic heart disease than non-diabetics, and those with SMI face similar or even greater risks of cardiovascular events compared to symptomatic patients [6].

Reported prevalence of SMI in T2DM varies widely—typically between 10% and 40%—depending on diagnostic techniques and study populations [7]. Screening methods such as exercise ECG, myocardial perfusion imaging, and stress echocardiography can detect SMI, yet in many low- and middle-income countries, including Pakistan, such evaluations are infrequently performed [8]. Limited resources, lack of awareness, and absence of national screening guidelines contribute to underdiagnosis and delayed management [9].

Common predictors of SMI in diabetic patients include older age, longer duration of diabetes, poor glycemic control (high HbA1c), hypertension, dyslipidemia, obesity, smoking, and microvascular complications such as retinopathy or nephropathy [10]. However, these factors vary across populations due to genetic, lifestyle, and environmental differences. Therefore, identifying population-specific predictors is crucial for designing effective screening and prevention strategies [11].

Research Gap and Objective: This study addresses the lack of regional data by determining the prevalence and predictors of SMI in patients with T2DM to support early detection and improved cardiovascular prevention.

Methodology

Study Design and Setting: This cross-sectional study was conducted over the course of nine months, from January 2024 to September 2024, at the Department of Cardiology, Lady Reading Hospital (LRH), Peshawar. Determining the prevalence and determinants of SMI in patients with T2DM was the goal of the study.

Study Population: Adult patients between the ages of 35 and 70 who had been attending LRH's outpatient and inpatient departments during the study period and who had a history of type 2 diabetes for at least a year were included in the study. The American Diabetes Association (ADA) criteria were used to diagnose diabetes.

Sample Size Calculation: Based on the already published studies, the sample size calculated based on the WHO sample size calculator was calculated using the formula based on a single population proportion [12] with a confidence level of 95, a margin of error of 5 and a prevalence of SMI in diabetic patients of 25%. A sample size of 288

participants was arrived at as the required minimum. A total of 300 patients were recruited to the study to accommodate any non-response and incompleteness of the data.

Inclusion and Exclusion Criteria: The participants in the study were adult patients with T2DM of both genders and willing to take part in the study and gave informed written consent. Patients with a history of myocardial infarction, heart failure, ischemic heart disease, severe valvular heart disease, or chronic renal disease of stage 4 or above were not permitted to participate in the trial. Moreover, participants using medications that might conceal the symptoms of ischemia like beta-blocker were eliminated as well to prevent the impreciseness of symptom measurement and diagnostic procedures.

Sampling Technique: used a consecutive sampling method. Any qualified patients who came to the cardiology or endocrinology clinic at the study period and qualified on the inclusion criteria were invited to take part until the required sample size was achieved.

Data Collection Procedure: Upon informed consent, demographic and clinical information such as age, gender, duration of diabetes, smoking history, body mass index (BMI), blood pressure and treatment history were captured using a predesign proforma. Laboratory values including fasting blood glucose, HbA1c, lipid profile and serum creatinine were also received.

All participants were subjected to a resting 12-lead electrocardiogram (ECG) and treadmill exercise stress test (TMT) in order to determine silent myocardial ischemia. Physically constrained patients undergoing exercise testing were unable to do so and a pharmacologic stress test was done with dipyridamole or adenosine, with myocardial perfusion scintigraphy was done where necessary. SMI was diagnosed in participants who demonstrated ischemic ECG changes or perfusion defects during stress testing in the absence of anginal symptoms.

Data Analysis: The data was entered and analyzed using SPSS version 26.0. While continuous factors including age, the duration of their diabetes, and laboratory findings were expressed as mean ± standard deviation (SD), categorical data such as gender, smoking status, hypertension, and the existence of SMI were expressed as frequencies and percentages. The independent t-test was used to assess continuous data, while the chi-square test was used to assess the associations between categorical variables. To identify independent drivers of SMI, multivariate logistic regression analysis was employed. A statistically significant P-value was defined as less than 0.05.

Ethical Considerations: Ethical approval was granted by Lady Reading Hospital's Institutional Review Board (IRB) in Peshawar. All participants gave written informed consent prior to participating in the study. All information was kept confidential and utilized exclusively for the study in accordance with ethical research norms.

Results

The mean age of the 300 patients with T2DM who were enrolled was 54.3 ± 8.9 years, and 52.7% of them were men. As shown in Table 1, the majority of patients had poor glycemic control, with an average HbA1c score of 8.4 ± 1.6% and an average duration of diabetes of 9.2 ± 5.1 years. Hypertension and dyslipidemia were common comorbidities, present in 58.7% and 46.0% of patients, respectively, while 24% were smokers. The mean BMI was 27.6 ± 3.8 kg/m², total cholesterol 205.8 ± 39.4 mg/dL, LDL-C 126.5 ± 32.8 mg/dL, HDL-C 40.7 ± 8.9 mg/dL, and serum creatinine 1.02 ± 0.3 mg/dL.

Table 1: Study participants' baseline characteristics (n = 300)

Variable	Mean ± SD / n (%)
Age (years)	54.3 ± 8.9
Gender	
Male	158 (52.7%)

Female	142 (47.3%)
Duration of diabetes (years)	9.2 ± 5.1
BMI (kg/m²)	27.6 ± 3.8
Hypertension	176 (58.7%)
Dyslipidemia	138 (46.0%)
Smoking	72 (24.0%)
HbA1c (%)	8.4 ± 1.6
Total Cholesterol (mg/dL)	205.8 ± 39.4
LDL-C (mg/dL)	126.5 ± 32.8
HDL-C (mg/dL)	40.7 ± 8.9
Serum Creatinine (mg/dL)	1.02 ± 0.3

Legend: The data is displayed as either a number (%) or mean ± standard deviation (SD). BMI stands for body mass index; LDL-C and HDL-C stand for low-density lipoprotein cholesterol and high-density lipoprotein cholesterol, respectively.

Out of 300 participants, 83 (27.7%) were diagnosed with silent myocardial ischemia (SMI) based on stress testing and ECG findings. Table 2 shows that men had a considerably higher prevalence of SMI (69.9%) than women (30.1%) (χ^2 = 6.19, p = 0.013). The duration of diabetes was longer (11.8 ± 5.2 vs. 8.1 ± 4.7 years; t = 5.28, p < 0.001), the HbA1c values were higher (9.1 ± 1.7 vs. 8.1 ± 1.5%; t = 4.49, p < 0.001), and the patients with SMI were older (57.1 ± 8.2 vs. 53.2 ± 8.9 years; t = 3.32, p = 0.001). SMI was also substantially correlated with smoking (χ^2 = 7.04, p = 0.008), hypertension (χ^2 = 12.21, p < 0.001), and dyslipidemia (χ^2 = 10.72, p = 0.001).

Table 2: Comparative Analysis of Clinical Features in Patients with and Without SMI

Variable	SMI Present (n = 83)	SMI Absent (n = 217)	Test Value	p-value
Age (years)	57.1 ± 8.2	53.2 ± 8.9	t = 3.32	0.001
Male Gender	58 (69.9%)	100 (46.1%)	χ^2 = 6.19	0.013
Duration of Diabetes (years)	11.8 ± 5.2	8.1 ± 4.7	t = 5.28	<0.001
BMI (kg/m²)	28.2 ± 3.6	27.3 ± 3.9	t = 1.59	0.112
Hypertension	63 (75.9%)	113 (52.1%)	χ^2 = 12.21	<0.001
Dyslipidemia	52 (62.7%)	86 (39.6%)	χ^2 = 10.72	0.001
Smoking	29 (34.9%)	43 (19.8%)	χ^2 = 7.04	0.008
HbA1c (%)	9.1 ± 1.7	8.1 ± 1.5	t = 4.49	<0.001

Legend: Independent t-tests were used to evaluate continuous variables, and chi-square tests were used to analyze categorical variables. In terms of statistics, a p-value < 0.05 was deemed significant.

SMI was substantially more common in those with poorer glycemic control and longer duration of diabetes. Figure 1 shows that 35.5% of patients with HbA1c ≥ 8% had SMI, while 13.2% of patients with HbA1c < 8% had SMI (p < 0.001).

Likewise, individuals who had diabetes for more than ten years had a significantly greater prevalence of SMI (38.8%) compared to those who had the condition for less than ten years (17.5%; p = 0.002). These findings highlight the strong impact of chronic hyperglycemia and prolonged diabetes on cardiovascular risk.

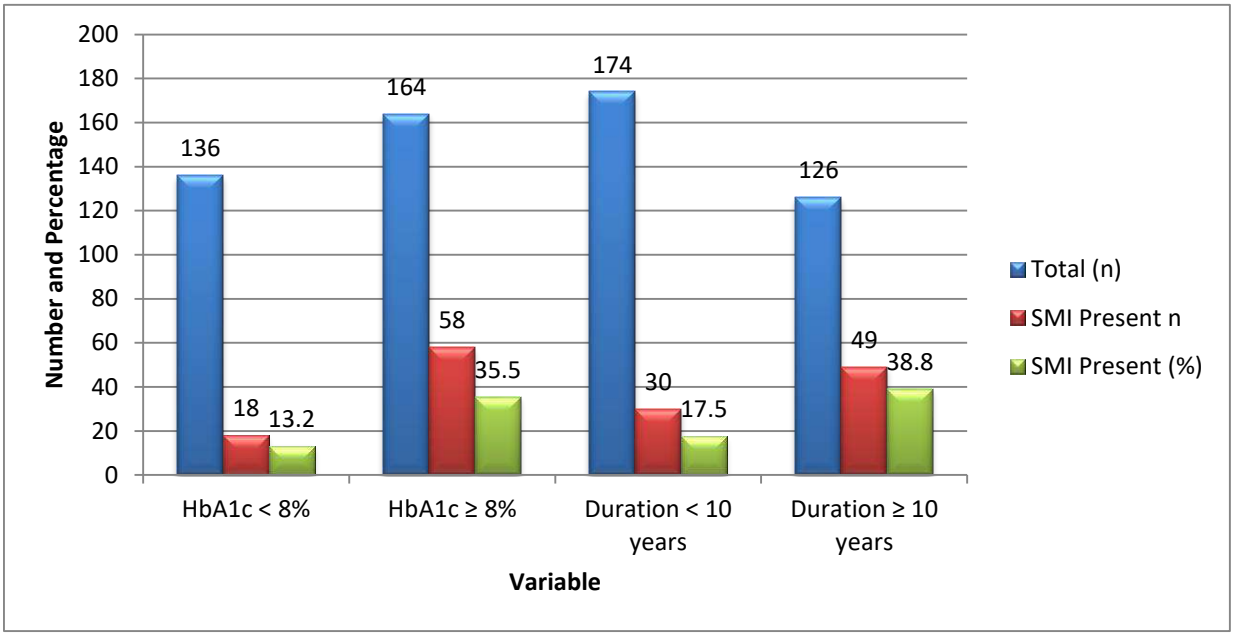


Figure 1: Association of SMI with Glycemic Control and Duration of Diabetes

Legend: The figure shows that SMI prevalence was 35.5% among patients with HbA1c ≥ 8% and 13.2% among those with HbA1c < 8% ($p < 0.001$). Similarly, patients with diabetes duration ≥10 years had 38.8% SMI compared to 17.5% with <10 years ($p = 0.002$).

Among the 83 patients diagnosed with SMI, the majority (78.3%) exhibited ischemic changes on ECG, while 21.7% showed perfusion defects on myocardial scintigraphy. As illustrated in Figure 2, the most frequent ischemic pattern was inferolateral wall involvement, observed in 42% of patients, followed by anterior wall ischemia in 32.5% and inferior wall ischemia in 25.5%. These findings suggest that ECG remains the primary diagnostic tool for detecting SMI, with imaging providing additional confirmation in selected cases.

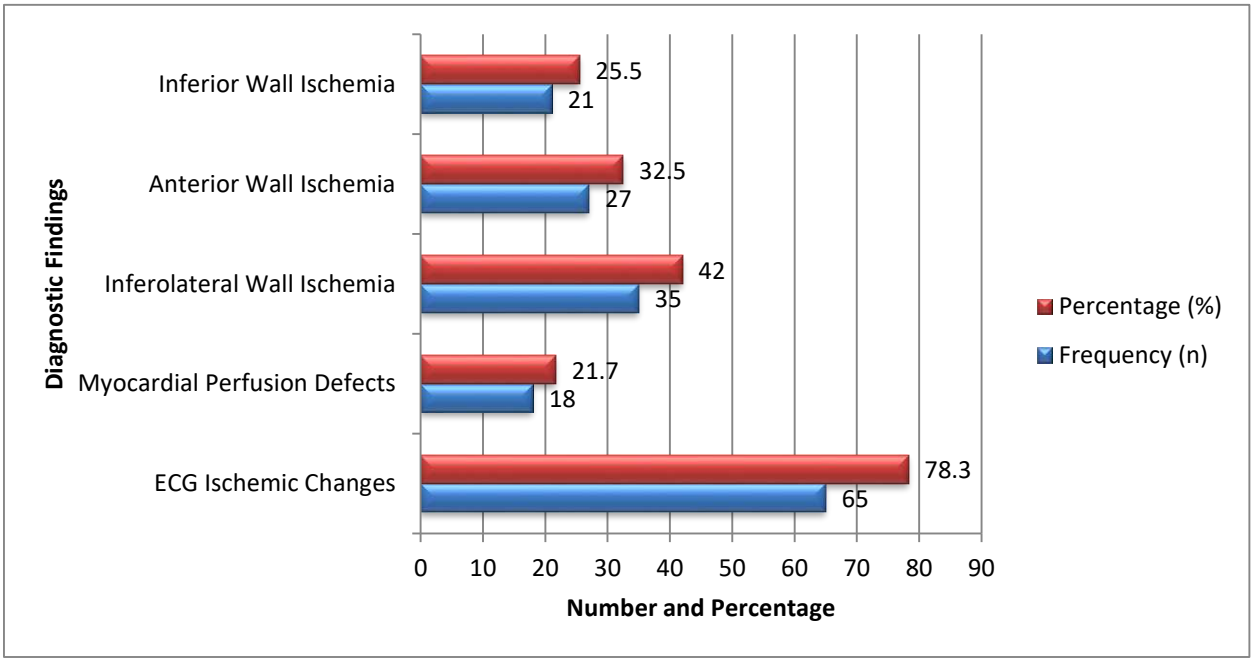


Figure 2: Distribution of ECG and Scintigraphy Findings among SMI-Positive Patients (n = 83)

Legend: ECG = electrocardiogram. Data represent the proportion of SMI-positive patients showing specific ischemic changes or perfusion defects.

Multivariate logistic regression analysis revealed that male gender, longer diabetes duration (≥10 years), hypertension, poor glycemic control (HbA1c ≥ 8%), and dyslipidemia were significant independent predictors of SMI. As shown in Table 3, poor glycemic control had the strongest association, increasing the odds of SMI nearly threefold (AOR = 2.78, 95% CI: 1.46–5.29, p = 0.002). Similarly, prolonged diabetes duration (AOR = 2.41, 95% CI: 1.38–4.22, p = 0.002) and hypertension (AOR = 1.94, 95% CI: 1.07–3.53, p = 0.028) were strong predictors. Dyslipidemia (AOR = 1.82, 95% CI: 1.02–3.24, p = 0.043) and male gender (AOR = 1.86, 95% CI: 1.04–3.32, p = 0.036) also showed significant associations, while smoking and age ≥ 55 years did not remain significant after adjustment.

Table 3: Multivariate Logistic Regression Analysis for Predictors of SMI

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Male Gender	1.86	1.04–3.32	0.036
Duration ≥ 10 years	2.41	1.38–4.22	0.002
Hypertension	1.94	1.07–3.53	0.028
HbA1c ≥ 8%	2.78	1.46–5.29	0.002
Dyslipidemia	1.82	1.02–3.24	0.043
Smoking	1.55	0.84–2.88	0.161
Age ≥ 55 years	1.29	0.72–2.32	0.386

Legend: Multivariate logistic regression analysis adjusted for confounding variables. AOR = adjusted odds ratio; CI = confidence interval. A p-value < 0.05 indicates statistical significance.

Discussion

This study found that 27.7% of patients with T2DM had SMI, with higher prevalence among males, hypertensive and dyslipidemic individuals, and those with poor glycemic control or longer diabetes duration. Multivariate analysis identified poor glycemic control (AOR 2.78) and diabetes duration ≥10 years (AOR 2.41) as the strongest predictors. These results highlight the silent but significant cardiovascular risk in diabetic patients, emphasizing the need for early screening and management.

The prevalence of SMI in this study (27.7%) aligns with the global range of 10–40% reported among diabetic patients [11]. Studies utilizing only exercise ECG generally report lower rates, whereas those incorporating imaging techniques tend to find higher detection rates, consistent with our findings where most cases were identified through ECG [13].

The strong association between poor glycemic control and prolonged diabetes duration is consistent with existing evidence demonstrating that chronic hyperglycemia and prolonged metabolic stress promote endothelial dysfunction and silent coronary disease [14]. Similarly, hypertension and dyslipidemia were significant predictors, echoing literature that highlights the combined effect of traditional cardiovascular risk factors in diabetics [15].

SMI was more prevalent in men, consistent with global data, while age showed only a mild association after adjustment [16]. The diagnostic pattern predominantly based on ECG matches findings from other resource-limited settings where stress ECG remains the primary screening tool [17]. Furthermore, the clustering of multiple cardiometabolic risk factors in SMI-positive patients aligns with international studies highlighting the additive effect of metabolic syndrome components on ischemic burden [18].

Overall, our results are in close agreement with international literature, reinforcing that SMI is common in diabetics and closely tied to glycemic control, disease duration, and coexisting cardiovascular risks. Minor differences in prevalence likely reflect population characteristics and diagnostic approaches.

Limitations and Future Suggestions: This was a single-center, cross-sectional study, which limits generalizability and causal inference. Coronary angiography was not routinely performed, and the study did not assess long-term outcomes. Additionally, selection bias may have occurred since hospital-based patients often have higher baseline cardiovascular risk.

Future studies should include multicenter longitudinal designs to confirm predictors and assess clinical outcomes. Incorporating advanced imaging and evaluating the impact of early screening and glycemic control on cardiovascular events would strengthen preventive strategies for diabetic populations.

Conclusion

This study showed that patients with T2DM had a high prevalence of SMI (27.7%), underscoring the significant cardiovascular risk in this group. The strongest independent predictors were poor glycemic control and a longer duration of diabetes, while dyslipidemia and hypertension also played a significant role. In order to prevent undiscovered ischemia episodes and enhance long-term outcomes, these findings highlight the significance of rigorous metabolic control and early cardiovascular screening in diabetic patients.

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