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Ajam A.O. ✉, Jasim R.A.
Al-Basrah Cardiovascular Specialist Hospital, Basrah, Iraq

Silent Myocardial Ischemia in Patients with Anterior ST Elevation Myocardial Infarction Treated by Primary Percutaneous Intervention

Conflict of interest: nothing to declare.
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Contacts: medicalresearch602@yahoo.com

Abstract

Introduction. Silent myocardial ischemia (SMI) is a condition marked by decreased oxygen-rich blood flow to the heart that doesn't involve any chest pain or other angina symptoms like dyspnea, nausea and diaphoresis. Only about 20 to 30% of all SMI are silent, and only about 5% of SMI in early treadmill-testing show signs of an adverse diagnosis.
Purpose. To quantify the prevalence of risk factors for silent myocardial ischemia in anterior STEMI patients receiving primary percutaneous coronary intervention (PCI).
Materials and methods. This prospective observational study included 50 patients diagnosed with anterior STEMI from the department of cardiology at Basrah Cardiac Center. There were two groups of patients: Group (A) included patients with TMT Positive, and Group (B) included patients with TMT Negative.
Results. At 6 months follow up, 15 patients (30%) had a positive treadmill test, while 35 patients (70%) were negative. The 15 patients who had a positive treadmill test were 80% male and 20% female. The mean age of patients with a positive exercise treadmill test was (63.70+3.71) years, 13 patients (86.6%) had diabetes (p=0.001), 10 patients (66.6%) were hypertensive, 14 patients (93.3%) had dyslipidemia, 5 patients (33.3%) were smokers, 3 patients (20%) were obese, and one patient (6.6%) had a family history of coronary artery diseases (CAD).
Conclusion. Thirty percent of the study population had silent myocardial ischemia. This demonstrates that CAD is a significant risk factor for further and even silent myocardial ischemia. Age, diabetes and dyslipidemia are all risk factors for silent myocardial ischemia.
Keywords: electrocardiogram, percutaneous coronary intervention, silent myocardial ischemia, ST-elevation myocardial infraction, treadmill testing

Аджам А.О. ✉, Джасим Р.А.
Специализированная сердечно-сосудистая больница Аль-Басра, Басра, Ирак

Безболевая ишемия миокарда у пациентов с острым инфарктом миокарда с подъемом сегмента ST, подвергавшихся первичному чрескожному коронарному вмешательству

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Резюме

Введение. Безболевая ишемия миокарда (БИМ) – это состояние, характеризующееся снижением притока богатой кислородом крови к сердцу, которое не сопровождается болью в груди или другими симптомами стенокардии, такими как одышка, тошнота и потливость. БИМ не проявляется в 20–30% случаев, и только около 5% случаев обнаруживается при раннем тредмил-тестировании.
Цель. Количественно оценить распространенность факторов риска БИМ у пациентов с острым инфарктом миокарда с подъемом сегмента ST (ИМпST), подвергающихся первичному чрескожному коронарному вмешательству.
Материалы и методы. В проспективное обсервационное исследование были включены 50 пациентов с острым ИМпST из кардиологического отделения Кардиологического центра Басры. Пациенты были разделены на две группы: группа А включала пациентов с положительным тредмил-тестом, группа В – с отрицательным.
Результаты. Через 6 месяцев наблюдения 15 пациентов (30%) продемонстрировали положительный результат тредмил-теста, 35 (70%) – отрицательный. Среди 15 пациентов с положительным тестом было 80% мужчин и 20% женщин. Средний возраст пациентов с положительным тестом составил 63,70+3,71 года; у 13 пациентов (86,6%) был сахарный диабет (p=0,001), у 10 (66,6%) – артериальная гипертензия, у 14 (93,3%) – дислипидемия. Пять пациентов (33,3%) были курильщиками, 3 (20%) страдали ожирением, 1 (6,6%) имел семейный анамнез коронарной болезни сердца.
Заключение. 30% исследуемой популяции имели БИМ. Это свидетельствует о том, что коронарная болезнь сердца является серьезным фактором риска развития в будущем ишемии миокарда, в том числе безболевой. Возраст, сахарный диабет и дислипидемия являются факторами риска БИМ.
Ключевые слова: электрокардиограмма, чрескожное коронарное вмешательство, безболевая ишемия миокарда, инфаркт миокарда с подъемом сегмента ST, тредмил-тест

■ INTRODUCTION

A condition known as silent myocardial ischemia (SMI) is when there is objective proof of ischemia but no angina or other comparable symptoms. Diagnostic tests that are non-invasive (such as stress tests, Holter ECGs, myocardial perfusion imaging, and echo stress) or, more recently, invasive tests using coronary pressure during catheterization can provide objective proof of SMI [1]. According to estimates, between 25 and 50 percent of patients with ischemic heart disease experience silent ischemic episodes, which outnumber symptomatic episodes by a factor of more than 20:1 [2].

Disturbances in myocardial blood flow, metabolism, function, and electrical activity without obvious clinical manifestations are referred to as SMI [3].

SMI can exist independently of other forms of coronary artery disease or in combination with them. When there is a SMI, the risk of sudden cardiac death increases by 10 times, that of an arrhythmia by 2, and that of myocardial infarction and heart failure by 1 to 1.5 times [4].

■ PURPOSE OF THE STUDY

To quantify the prevalence of risk factors for silent myocardial ischemia in anterior STEMI patients receiving PCI.

■ MATERIALS AND METHODS

In this prospective observational study, 50 patients from Basra Cardiac center's attendants who had been diagnosed with anterior ST elevation myocardial infarction (STEMI) and who had undergone primary percutaneous intervention (PCI) with complete revascularization of all lesions and no signs of residual coronary stenosis were enrolled.

All study participants underwent primary PCI and presented within 12 hours of the onset of their symptoms with an ECG demonstrating persistent ST-segment elevation myocardial infarction, specifically anterior STEMI.

STEMI was defined as ST elevation at the J point in at least two consecutive leads ≥2.5 mm in men <40 years, ≥2 mm in men ≥40 years, or ≥1.5 mm in women regardless of age in leads V2–V3.

Patients who underwent coronary artery bypass grafting (CABG) surgery or thrombolysis in addition to primary PCI were not included. The following ECG abnormalities were also excluded: Wolff-Parkinson-White pattern, Ventricular paced rhythm, Left Bundle Branch Block, Greater than 1 mm ST depression at rest, and Left Ventricular Hypertrophy with ST-T abnormalities. Patients with residual angiographically – significant coronary stenosis after primary PCI, symptoms suggestive of CAD or documented ischemia at follow-up, and patients with symptoms of ischemia were also not included in the study.

All patients who signed up had to provide information about their medical history, including whether they had high blood pressure or diabetes, and whether they were taking medication to treat either condition. Smoking, dyslipidemia, obesity, and early CAD in the family are all risk factors.

The comprehensive assessment of general health include taking blood pressure, heart rate, and rhythm readings, looking for any signs of pulmonary venous congestion, examine heartbeats or murmurs, looking for ascites, lower limb edema, and other signs of systemic venous congestion include hepatomegaly.

At admission and follow-up visits (1, 3 and 6 months after discharge), a 12-lead electrocardiogram (ECG) was obtained. Serum cardiac biomarkers (troponin I, creatine kinase, and myocardial band of creatine kinase) were examined in the laboratory. Lipid profile measured three and six months after discharge and at follow-up. To detect abnormalities in wall motion or ischemic complications (LV systolic dysfunction, LV aneurysm, LV thrombus, Secondary mitral valve regurgitation), transthoracic echocardiography (TTE) was performed in all included patients using a Toshiba ultrasound machine prior to discharge and at follow-up (1, 3 and 6 months after the event) in accordance with the recommendations of the American Society of Echocardiography.

Coronary Angiography and Primary PCI within the time frame recommended by current guidelines (if symptoms of ischaemia are less than 12 hours old and the ST segment is persistently elevated). Mild coronary artery stenosis is defined as a narrowing of less than 50%, moderate stenosis as a narrowing of 50% to 70%, and severe or significant stenosis as a narrowing of 70% or more. For all patients with multi-vessel disease, complete revazcularization of significant stenosis in non-Infarction Related arteries was performed.

According to the Bruce Protocol, a treadmill stress test (TMT) was performed three months after the incident as long as the patients did not exhibit any myocardial ischemia-related symptoms or any new, confirmed ischemic events. The main factors to be taken into account when interpreting the exercise ECG are the existence or absence of ischemic ECG changes and any exercise-induced arrhythmias. 80 ms after the J point was considered "positive" for ischemia by TMT when patient had visible 1 mm of horizontal or downward-sloping ST segment depression in one or more leads. Depression of the J point, which marks the beginning of the ST segment and the end of the QRS, frequently happens when heart rates increase during exercise. This depression is most likely brought on by atrial repolarization that continues through the QRS rather than myocardial ischemia. Less than 80 milliseconds pass in this instance before the ST segment reaches its baseline value. The two groups into which the patients were divided were TMT Positive patients (A) and TMT Negative patients (B).

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) latest version was the tool of choice for all our statistical analyses. The descriptive statistics, including means, standard deviations, frequencies, and percentages, for all study variables. We fixed the level of statistical significance at $p<0.05$ and ensured all p-values were two-sided.

■ RESULTS

The average age was 49.34±7.53 with a range of 34–68 years and the majority of the studied cases were less than fifty years (60.7%). The difference between the mean ages of patients with positive and negative TMT was statistically significant at (60.6±3.8) years and (50.7±7.7) years, respectively (Table 1).

Women made up 36% (18 patients), while men made up 64% (32 patients) of the study population. 50% (25 patients) had hypertension, 46% (23 patients) had diabetes, 58% (29 patients) were smokers. 15 patients (30%) out of the 50 patients had a positive exercise treadmill test (TMT) at a 6-month follow-up, while 35 patients (70%) had a negative TMT. Throughout the follow-up period, every patient was completely symptom-free. Six patients (40%) of those with positive TMT results and 13 (37.1%) of those with negative

results smoked, this was a statistically insignificant (p=0.122). Statistically insignificantly, only 9 patients (25.7%) of those with negative TMT were obese, compared to 4 patients (26.6%) of those with positive TMT (p value p=0.624). In patients with positive TMT at follow-up, one patient (6.6% of patients) had family history of CAD, compared to two patients (5.7%) with negative TMT, which is statistically insignificant (p=0.634).

This table (2) Illustrates that 10 patients (66.6%) of the 15 patients with positive TMT were male, and 5 patients (33.4%) were female. While 22 (62.8%) of the 35 patients with negative TMT were male and 13 patients (37.2%) were female. Statistically speaking, this difference was not significant (p=1.000).

This table (3) illustrates that 50% (25 patients) had hypertension, 48% (24 patients) had diabetes, 38% (19 patients) were smokers. Six patients (40%) of those with positive TMT results and 13 (37.1%) of those with negative results smoked, this was a statistically insignificant (p=0.122). Statistically insignificantly, only 9 patients (25.7%) of those with negative TMT were obese, compared to 4 patients (26.6%) of those with positive TMT (p value p=0.624). In patients with positive TMT at follow-up, one patient 6.6% of patients had family history of CAD, compared to two patients (5.7%) with negative TMT, which is statistically insignificant (p=0.634). 12 patients (80%) of those with positive TMT results and 13 (37.1%) of those with negative results had hypertension, this was a statistically significant (p=0.000). 13 patients (86.6%) of those with positive TMT results and 11 (31.4%) of those with negative results had diabetes, this was a statistically significant (p=0.000). 14 patients (93.3%) of those with positive TMT results and 13 (37.1%) of those with negative results had diabetes, this was a statistically significant (p=0.000).

Figure illustrates that six patients (40%) of those with positive TMT results and 13 (37.1%) of those with negative results smoked. Only 9 patients (26.6%) of those with positive TMT were obese, compared to 4 patients (25.7%) of those with negative TMT. In patients with positive TMT at follow-up, one patient (6.6% of patients) had family history of CAD, compared to two patients (5.7%) with negative TMT, which is statistically insignificant.

Table 1
Comparison between the studied groups as regard age

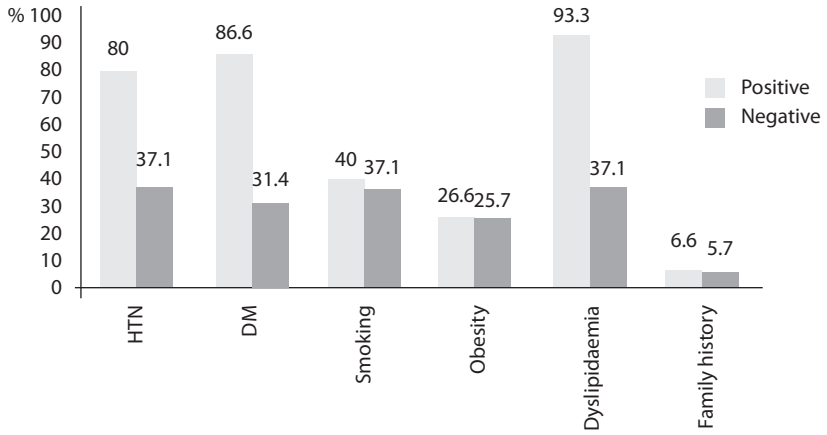
Variable	Total number of patients (50)	Group (A) patients with TMT Positive (15)	Group (B) patients with TMT Negative (35)	P
Age Mean+SD	49.34±7.53	60.6+3.8	50.7+7.7	<0.001

Table 2
Comparison between the studied groups of sex

Sex	Total number of patients (50)		Group (A) patients with TMT Positive (15)		Group (B) patients with TMT Negative (35)		P
	N	%	N	%	N	%	
Male Female	32 18	64 36	10 5	66.6 34.4	22 13	62.8 37.2	>0.05

Table 3
Comparison between the studied groups of risk factors

Risk factors	Total number of patients (50)		Group (A) patients with TMT Positive (15)		Group (B) patients with TMT Negative (35)		P
	N	%	N	%	N	%	
HTN	25	50	12	80	13	37.1	<0.001
DM	24	48	13	86.6	11	31.4	<0.001
Smoking	19	38	6	40	13	37.1	>0.05
Obesity	13	26	9	26.6	4	25.7	>0.05
Dyslipidemia	27	54	14	93.3	13	37.1	<0.001
Family history	3	6	1	6.6	2	5.7	>0.05



Risk factors were compared between the two study groups

■ DISCUSSION

Silent myocardial ischemia (SMI) is a relatively common condition but misunderstood clinical entity [5]. It is defined as objective and verified evidence of myocardial ischemia in the absence of chest pain or other anginal equivalent symptoms.

Patients with silent ischemia were more likely to experience critical events than those without ischemia, but less likely than those with symptomatic ischemia, despite the fact that the incidence of silent ischemia patients who had successfully undergone angioplasty and stenting is variable. Although patients with silent ischemia fared worse in terms of event-free survival than those with symptomatic ischemia, asymptomatic ischemia was associated with a worse prognosis than ischemia alone [6].

Our research was prospective observational in nature 50 patients who were diagnosed with anterior ST elevation myocardial infarction (STEMI) and received primary PCI participated in this observational study. The patients were monitored for six months to detect silent myocardial ischemia using clinical evaluation, ECG, echocardiography, and the treadmill test, which was divided into positive and negative silent myocardial ischemia depending on the results.

Zellweger et al. [6] looked at 356 silent patients who had undergone a fruitful angioplasty and stenting for ischemia followed by myocardial perfusion. Eighty-one Patients who had target vessel evidence (23%) were found .Ischemia, which was silent in 62% of patients.

In our study, there were silent in 30% of all study cases while 86.6% of diabetics had myocardial ischemia.

According to Taher al., our findings are in agreement [7] who demonstrated that silent ischemia is more common in Diabetics make up 45% of the patients who are silent ischemia. There were 26 patients in the group (32.5% of the total) without chest pain and with stress-related ST depression. Among them 18 patients (or 69.2% of them) had ischemia were diabetics. According to their study, diabetics with coronary artery disease have a higher prevalence of silent myocardial ischemia than do non-diabetic patients with the same condition.

In addition to a study by Nisha Arenja et al. [8] in diabetics, the SMI prevalence was 28.5%.

Despite different numbers, non-diabetics had a 21.5% prevalence rate, so silent myocardial ischemia greater among diabetics. Furthermore, they agree with a retrospective study from Kathiresan et al. [9] to identify silent myocardial ischemia using a 12-lead continuous, measure ischemia for monitoring of electrocardiograms in patients who had PCI. Despite positive angiographic outcomes one-third of the patients had silent myocardial ischemic symptoms following surgery.

SMI was discovered to be less common in the work of Tavkaeva than in our study, where SMI was found in only 6.6 percent of patients who underwent catheterization stenting after 6 months. Nevertheless, this study utilize variable risk factors and Holter ECG monitoring than the research we conducted [10].

SMI, however, was discovered to be more common in The ADORE2 trial (The Aggressive Diagnosis of Restenosis in patients at high risk). They discovered that at 1.5 month and 6 months, respectively, 27 percent and 41.9 percent of patients undergoing routine functional testing had a positive functional test [11].

We found that, out of 50 patients, 15 patients (30%) had a positive Exercise Treadmill Test at 6 months follow up and 35 patients (70%) were negative.

Previous research by Cristina Hernández et al. [12] using SPECT MPI, claims that. In a study of 41 type 2 diabetic patients, reported that SMI was present in 21.9% of diabetics. Furthermore, the DIAD study (Detection of Silent Myocardial Ischemia in Asymptomatic Diabetic Subjects) found that more than one in five type 2 asymptomatic diabetes patients have silent myocardial ischemia [13].

In our study, hypertensive made up 50% of the patient population 48% of them had proof of silence, adherence to myocardial ischemia, and this drugs for the period following a myocardial infarction. So, the link between silent and controlled hypertension may be weaker. This research by Lubaszewski et al. [14] is comparable to the accompanying silent myocardial ischemia and presence of arterial disease, diabetes mellitus, and hypertension who discovered SMI. Having both risk factors more frequently than just hypertension (and diabetes) (29.3% vs. 12.5%).

Moreover, Rodrigo Modolo et al. [15] conducted a study on patients with hypertension have a high prevalence of myocardial ischemia. About 36 patients (28%) had myocardial ischemia.

In our study, more than half of the patients with dyslipidemia also had myocardial ischemia that was virtually silent. This is in line with the findings of a study by Ariane et al. [16], which found a significant correlation between non-HDL cholesterol, LDL cholesterol, microangiopathy and silent myocardial ischemia.

■ CONCLUSION

Silent myocardial ischemia was found in more patients in this study of short-term follow-up with patients after acute ST elevation myocardial infarction treated with primary coronary intervention (PCI) over one-fourth of the study's participants. This demonstrates that myocardial ischemia can progress and even become silent in people with coronary artery diseases which considered major risk factor for silent myocardial ischemia. The causes of silent myocardial ischemia are advanced age, diabetes mellitus, and dyslipidemia rather than mechanical issues or other risk factors.

■ REFERENCES

1. Indolfi C., Polimeni A., Mongiardo A., De Rosa S. *European Heart Journal Supplements.* 2020:L82–L85.
2. Ahmed A.H., Shankar K., Eftekhari H., Munir M., Robertson J. Silent myocardial ischemia: Current perspectives and future directions. *Experimental and clinical cardiology.* 2007;12(4):189–96.
3. Abdrakhmanova A.I., Amirov N.B., Sayfullina G.B. Painless myocardial ischemia (literature review). *Bulletin of modern clinical medicine.* 2015;6:103–15.
4. Golukhova E.Z., Gromova O.I., Bulaev N.I. Sudden cardiac death in patients with coronary heart disease: from mechanisms to clinical practice. *Cardiology.* 2017;12:73–81.
5. Theodoros-Xanthos K. Reviewing myocardial silent ischemia: Specific patient subgroups international. *Journal of Cardiology.* 2008;24(5):139–48.
6. Michael J., Zellweger H., Markus Weinbacher F. Long-Term Outcome of Patients with Silent Versus Symptomatic Ischemia Six Months After Percutaneous Coronary Intervention and Stenting. *Journal of the American College of Cardiology.* 2003;42(1):99104.
7. Mohammed A., Iman E., Ibrahim J. Study of silent myocardial ischemia using exercise stress test among diabetic and non-diabetic patients with documented coronary artery disease. *The Egyptian Heart Journal.* 2012;64(1):105–8.
8. Nisha A., Christian M., Niklas F. Prevalence, Extent, and Independent Predictors of Silent Myocardial Infarction. *The American Journal of Medicine.* 2013;12(6):515–22.
9. Kathiresan S., Jordan K., Gimelli G., Lopez-Cuellar J., Madhi N., Jang K. Frequency of silent myocardial ischemia following coronary stenting. *Am J Cardiol.* 1999;8(4):930–2.
10. Tavkaeva D., Mayanskaya K. The structure of painless myocardial ischemia in patients with myocardial infarction after percutaneous coronary intervention or conservative therapy. *Theses of the All-Russian Conference – Contradictions of Modern Cardiology: Controversial and Unresolved Issues. Samara.* 2018;12(3):181–201.
11. Eisenberg M., Wilson B., Lauzon C. Routine functional testing after percutaneous coronary intervention: results of the aggressive diagnosis of restenosis in high-risk patients (ADORE II) trial. *Acta Cardiol.* 2007;62(2):143–50.
12. Hernández C. Prevalence and risk factors accounting for true silent myocardial ischemia: a pilot case-control study comparing type 2 diabetic with non-diabetic control subjects. *Cardiovascular Diabetology.* 2011;12(2):212–220.
13. Frans J., Wackers M. Detection of Silent Myocardial Ischemia in Asymptomatic Diabetic Subjects. *DIABETES CARE.* 2004;27(8):100–21.
14. Lubaszewski K., Kawecka-Jaszcz D., Czarnecka F. Silent myocardial ischaemia in patients with essential arterial hypertension and non-insulin dependent diabetes mellitus. *Journal of Human Hypertension.* 1999;13(9):309–13.
15. Modolo R. Predictors of Silent Myocardial Ischemia in Resistant Hypertensive Patients. *American Journal of Hypertension, Ltd.* 2014;12(3):99–105.
16. Sultan A. Risk factors for silent myocardial ischemia in high-risk type 1 diabetic patients. *Diabetes care.* 2004;27(2):33–40.