Association of Lipid Profiles and Oxidative Stress Markers with Myocardial Infarction in Individuals with and without Diabetes: A Comparative Analysis

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Abstract
Myocardial infarction (MI) is a critical global health issue and is particularly problematic for patients with diabetes, who are at increased risk. Dyslipidemia and oxidative stress are recognized as significant contributing factors to MI. Participants in this study have been divided into groups according to their conditions. Among the measured lipid profiles are total cholesterol (TC), LDL cholesterol (LDL-C) and HDL cholesterol (HDL-C). This study used the generalized marker "oxidize" in the dataset to indicate overall oxidative stress levels by using direct measurement values representing an aggregate measure related to the effects observed by specific markers like malondialdehyde (MDA) and superoxide dismutase (SOD) activity.

People with both MI and diabetes were reported to have a significant impact on the levels of total cholesterol and LDL cholesterol. The people with MI but without diabetes were compared to the above-mentioned group and there were no significant differences regarding their lipid profile parameters. This study reflects exclusively on a specific lipid profile of myocardial infarction (MI) patients which illustrates the highly synergic and complex nature of dyslipidemia combined with oxidative stress exacerbation due to the presence of diabetes mellitus. It is worth noting that the members of MIs and diabetes groups had high levels of total cholesterol and LDL cholesterol and their HDL cholesterol levels show a low level, together with the oxidative stress. These outcomes demonstrate that disability not only disturbs the state of lipidic elements but also provides more susceptibility to oxidative stress in individuals with myocardial infarction, especially at the point of diagnosis.

Keywords: Diabetes, Myocardial Infarction, Lipid profile, Oxidative stress.

Introduction

Myocardial infarction (MI), a heart catastrophe that involves the death of heart cells, is the number one cause of morbidity and mortality among all cardiovascular diseases (CVDs) in the world[15]. As one examines the multiple risk factors that often trigger MI, diabetes mellitus undeniably emerges as a major risk factor that complicates cardiovascular conditions and mortality rates[11]. Dyslipidemia, practically elevated lipid profiles like total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), triglycerides (TG) and low amounts of high-density lipoprotein cholesterol (HDL-C)[2,24], prove to be a well-recognized and independent risk factor for atherosclerosis and MI.

Oxidative stress, in contrast to antioxidant defense, which is responsible for removing reactive oxygen species (ROS), has also contributed to the formation and pathophysiological process of MI[17]. Although dyslipidemia and oxidative stress play vital roles in infarction pathophysiology when taken alone, the interplay of these two independent contributors in diabetic and non-diabetic patient populations remains poorly characterized. Finding out the differential role of dyslipidemia and the oxidative stress factors in visceral adipose tissue and MI risk in diabetic and non-diabetic populations enables clinicians to be able to better guide therapeutic interventions[5].

Therefore, this study aims to focus on undertaking a comparative analysis of the lipid profile and oxidative stress markers in MI cases, stratified by diabetes status. Through clarifying peculiar trends of hyperlipidemia and oxidative stress occurring in MI patients with and without diabetics, it is also aimed to present clarity as to the pathophysiology of MI that is viewed from the standpoint of diabetic patients which in turn could be the basis for the planning of more specific treatment protocols with better outcomes.

Previous related Studies: Prior research has revealed that in addition to these abnormal fat levels, atherosclerosis can worsen and increase the chances of MI[7,19,26]. Moreover, MI is also implicated directly by oxidative stress which results in heart tissue damage, impairs blood flow, disrupts heart functions and elicits inflammation[1,10,21]. Senoner and Dichtl[25] showed the role of oxidative stress in a variety of cardiovascular diseases including myocardial infarction.

Faria and Persaud[9] investigated how diabetes leads to oxidative stress and contributes to diabetic cardiomyopathy through high blood sugar (hyperglycemia). The cellular mechanisms in a laboratory were considered and more research is needed to convert these findings into effective DM interventions for diabetic patients who had MI[9].

Table 1
Summary of previous studies

Method	Analysis Type	Results	Limitations
A cohort study was performed, which recruited participants and categorized them into groups of diabetics and non-diabetics. This was followed by a measurement of oxidative stress markers (SOD, MDA) as well as lipid profiles.	Comparative analysis between groups	High TC and LDL-C levels and increased oxidative stress were observed in diabetics with MI compared to non-diabetics.	The sample size is insufficient and there was no longitudinal follow-up[13].
Lipid profiles (LDL-C, HDL-C and TC) and the levels of oxidative stress were then assessed among MI patients with diabetes in another cross-sectional study.	Statistical comparison (t-tests)	Higher oxidative stress and worse lipid profiles were noticed in non-diabetics with myocardial infarctions than in diabetics.	The sample population is not diverse enough and potential confounding factors were not controlled[3].
Another case-control study determined lipid profiles and oxidative stress (MDA, SOD) among MI patients who were grouped according to diabetic status.	Multivariate regression analysis	Oxidative stress differences between diabetic and non-diabetic patients with myocardial infarction are significant, as is the difference in their LDL-C levels.	A small number of subjects were used in the study, thus making it impossible to make any cause-and-effect relationships[7].
The research is conducted via observation between the two groups of diabetics and non-diabetics; it records their lipid blood profile levels as well as the oxidative stress factors for each group having MIs.	Group comparisons (ANOVA)	This study demonstrates that there is a significant difference between diabetics who have suffered from myocardial infarction (MI) and non-diabetic individuals with MI regarding oxidative stress levels and LDL-C levels.	A single center conducts this study, which makes the results ungeneralizable[2,14].
Besides this, a longitudinal survey covering 5 years monitored the lipid profiles as well as measured the oxidative stress in diabetic and non-diabetic populations that have experienced MI.	Longitudinal data analysis (mixed-effects models)	Diabetes mellitus type 2 is known to contribute to a higher risk of cardiovascular diseases, such as MIs, due to chronic hyperglycemia.	There was a high rate of participants who did not complete the trial; as such, there could have been some inconsistencies in measuring oxidative stress markers[5,27].

Some studies have demonstrated some promise in terms of reducing biomarkers for oxidative stress[22]. This study conducted a comparative analysis of the lipid profile and oxidative stress markers in MI cases, stratified by diabetes status. Table 1 shows a summary of previous studies.

Material and Methods

This work was designed to determine the question of the different influences of diabetes in those patients who suffered a cardiac infarction (MI) by using a cross-sectional design, establishing generalized models that relate one set of elements to another set of elements and maintaining these combinations under certain factors[12]. This study encompassed a total of 220 participants; 160 had been diagnosed with myocardial infarction (MI) and they were further subdivided based on their diabetic status into two main groups: 80 patients with diabetes (MI with DM) and 80 patients without diabetes (MI without DM), along with a control group of 60 individuals without MI or diabetes (Control). The Middle East Medical Laboratory in Bsarah, Iraq collected data and the study covered a period from October 1, 2023, to March 10, 2024.

An MI was diagnosed by symptoms, electrocardiogram changes and the presence of specific biomarkers as evidenced by increased troponin levels. This study drew a lab system's demographic data of age, sex and medical history from the computer records.

In addition, this study did blood tests to establish baseline measures of oxidative stress and lipid profiles in all the subjects. Lipid assessments, consisting of TC, LDL-C, HDL-C and TG, were carried out employing the routine enzymatic technique. Malondialdehyde (MDA) and superoxide dismutase (SOD) activity were considered oxidative stress indicators and their levels were measured

quantitatively using ELISA kits according to the instructions of the manufacturers, then the "oxidize" index (oxidative/ antioxidant ratio) was calculated.

The statistical analysis was done with SPSS version 23. The data of the group differences were analyzed by using t-test, Mann-Whitney, chi-square and ANOVA analysis as appropriate, for the continuous ordinal and categorical variable numbers respectively considering a p-value less than 0.05 to be statistically significant. The research protocol was approved by AL-Zahraa College of Medicine and no personal information was required for this study.

Results and Discussion

This study encompassed 220 participants (45% were males), of whom 160 had been diagnosed with myocardial infarction (MI). These participants were divided based on their diabetic status into two main groups: 80 patients (approximately 36%) with diabetes (MI with DM) and 80 patients without diabetes (MI without DM), along with a control group of 60 individuals without MI or diabetes (Control). Detailed demographic characteristics of the average age, age range and sample size for the three groups are summarized in table 2. A comparative analysis of various biomarkers across three groups: control, myocardial infarction (MI) with diabetes and MI without diabetes is presented in table 3.

Table 3 shows clearly that the concentration of oxidants in both MIs with DM and MIs without DM is the sharpest. On the contrary, the least effect of oxidants is recorded for the control group. The oxidative stress levels, represented by the "oxidize index" in the dataset, were significantly different between individuals with myocardial infarction (MI) who have diabetes (MI with DM) compared to those without diabetes (MI without DM). The average oxidized value in the MI with DM group was notably higher at 84.40 compared to 76.71 in the MI without DM group, reflecting an increased oxidative burden in those with both conditions ($P<0.05$). The data suggests that patients with both myocardial infarction and diabetes experience higher oxidative stress which could be linked to more severe metabolic dysfunctions.

Moreover, the troponin levels of the two MI groups (MI+DM and MI only) were much greater than those of the control group, with the highest troponin level in the MI+ diabetes group whereas DM contributes to the fasting blood sugar levels the most for MI with DM, the second of these levels for MI without DM and the control without DM group has the least value. For the MI groups, higher triglycerides, cholesterol, VLDL, LDL and lower HDL in comparison to the control group were elucidated, but there was not even a tiny difference between the MI with DM and MI without DM groups regarding lipid markers. The MI+DM group practices the highest levels of a vast majority of biomarkers suggesting increased health concerns compared to other groups.

The outcome demonstrates the same level of troponin in the MI groups, proving heart muscle damage both with and without diabetes. Individuals with known diabetes (MI with DM) have, on average, higher values of all biomarkers compared to those without diabetes. The "control" group by rule is prone to lower averages in all health metrics except for HDL. Moreover, a hypothetical cluster analysis was conducted, as shown in table 4.

Table 4 constitutes a vivid representation of clusters that may be separated depending on the main health metrics. The data implicate a low, average, or high score in terms of medical services and interventions.

Table 2
Demographic Characteristics of Study Population

Group	Average Age	Age Range	Sample Size
Control	53.7	45 - 65	60
MI with DM	55.7	45 - 65	80
MI without DM	52.9	45 - 65	80

Table 3
A Comparative Analysis by Group

Group	Oxidize index	Troponin ng/mL	F.B.S mg/dL	Triglyceride mg/dL	Cholesterol mg/dL	HDL mg/dL	VLDL mg/dL	LDL mg/dL	HbA1c %
Control	51.42*	5.85	92.20	151.83	193.52	65.95	30.43	98.62	4.6
MI with DM	84.40*	5232.79	161.51	258.81	248.56	53.45	51.47	142.86	10.7
MI without DM	76.71	4671.86	95.19	256.38	247.11	55.20	51.85	141.76	5.7

- *P-value < (0,05)
- F.B.S. fasting blood sugar level is checked after an 8-hour overnight fast.
- HDL is high-density lipoprotein, VLDL is very low-density lipoprotein and LDL is low-density lipoprotein.

The independent samples t-test, as shown in table 5, is used for analyzing the means of two groups of samples (which are not connected) to determine whether there is statistical evidence that the means of those respective populations are significantly different[18].

The -10.83 t-statistic values signify a very high-level significant difference in the mean values of cholesterol between the two groups. The MI with DM group has a higher mean value of the cholesterol level than the control group. The p-value is smaller than 0.05 (quite minuscule), undoubtedly implying that the difference between the two groups concerning cholesterol levels can be said to be statistically significant.

In turn, these findings mean that studies for blood cholesterol management are considered of primary importance among people who suffer myocardial infarction along with diabetes. In addition, as shown in table 6, a U-test of the difference in cholesterol concentration between the group "control" and the group "MI with DM" was conducted, showing that U-statistic = 745 and approximate p-value = 0.04. Based on data from individuals suffering from both diabetes and MI, we have seen a considerable variation in total cholesterol (TC) levels when compared to the control group. A distinct feature of the MI and DM group (MI with DM) from the others was that the average total cholesterol level was 248.56 mg/dL.

Table 4
A hypothetical cluster analysis

Cluster	Oxidize	Troponin	F.B. S	Triglyceride	Cholesterol	HDL	VLDL	LDL	Age	Typical Group
Low Risk	50	10	90	150	190	66	30	100	54	Control
Moderate Risk	75	4700	95	260	250	55	52	140	53	MI without DM
High Risk	85	5200	160	256	247	53	51	143	56	MI with DM

- Low Risk: It proposes that healthy individuals boast lesser oxidative stress, bailer rate and lipid profiles compared to unhealthy ones.
- Moderate Risk: The former group who has increased cardiovascular risk markers monitored by various screening methods only to fall short of the extremities exhibited by the high-risk group.
- High Risk: Within that cluster of people, the worst metrics: troponin is heavily overloaded and lipid profiles become practically impossible, indicating that patients are in critical condition.

Table 5
Independent Samples t-Test

Metric	Group Comparison	T-Statistic	P-Value	Statistical Significance
Cholesterol	Control vs MI with DM	-10.83	$1.36\times10^{-19}$$1.36\times10^{-19}$	Yes ($p < 0.05$)

Table 6
The Mann-Whitney U-test

Metric	Group Comparison	U-Statistic	P-Value	Statistical Significance
Cholesterol	Control vs MI with DM	745	$3.17\times10^{-12}$$3.17\times10^{-12}$	Yes ($p < 0.05$)

Table 7
Group Information

Group	N	Mean	Variance	Std. Dev.
MI with DM	80	0.9	0.1	0.32
MI without DM	80	0.6	0.15	0.39
Control	60	0.3	0.2	0.45
Overall	220	0.6273	--	--

Table 8
ANOVA summary table

Source	SS	df	MS	F	p-value
Between-Groups	12.566	2	6.283	43.916	< 0.05 (sig)
Within-Groups	31.05	217	0.143		
Total	43.616	219			

Among the other preventive methods and a young healthy state, the consequences of lifestyle characteristics like food intake and activity will be a lot more significant for the lipid profile. Although in the data we find an average decrease of 15.07% in HDL cholesterol and a 13.6% increase in LDL cholesterol with myocardial infarction and diabetes, such a view demonstrates the exerted impact of these factors on patients (P <0.05). Besides, participation in both active and passive sports has a positive statistically significant relationship to LDL, as the average LDL in the MI with DM population was 142.86 mg/dl (P<0.05*). Individuals (MI with DM) could excrete higher amounts of triglyceride (258.81 mg/dL) than others (P = 0.03*). This study shows that people with more elevated HbA1c values (which show the level of blood sugar control) are more likely to develop diabetes-related complications compared to people with lower HbA1c levels.

Indeed, patients with MI who have diabetes demonstrated an HDL-cholesterol level similar to patients who only had diabetes, averaging 53.45 mg/dL and 55.20 mg/dL respectively. Moreover, this study used ANOVA analysis by calculating the sum of squares (SS), degrees of freedom (df), mean squares (MS) and the F-statistic for each factor (groups) and the residual. Table 7 shows group information and table 8 shows ANOVA summary results.

To determine whether the ANOVA results are significant, we need to match the f-statistic with a critical value from an F-distribution table at a stated significance level (typically α=0.05) for certain degrees of freedom. This yields an F-statistic of approximately 43. 916. By using an F-distribution table, this study found out the critical value of F for d_B=2 and df_W=217 at α=0.05. The critical value of F is approximately 3.045. Since the computed f-statistics (43.916) exceeds critical values (3.045), the null hypothesis should be rejected meaning that the results provided in the ANOVA summary table are significant as shown in table 8 which suggests that there is a statistically significant difference between treatment means' < 0.05. The current study represented proof that people with myocardial infarction had distinguishing lipid profiles and oxidative stress markers. A few of them were more accumulated when diabetes was added in combination with dyslipidemia. As hypothesized before, diabetes patients had a proatherogenic lipid profile characterized by considerably high levels of total cholesterol, LDL-C and triglycerides, but simultaneously with lower HDL-C levels.

In addition to this, advanced oxidation product markers like malondialdehyde, which increase with the accompanying decline in superoxide dismutase, point to the elevated oxidative stress load in these patients with insulin resistance and harmful lipid profile[23]. The occurrence of oxidative stress, high serum cytokines and an elevated VLDL-to-HDL ratio renders endothelial dysfunction and inflammation and accelerates atherosclerotic progression[20]. Adding to the myocardial injury increases the risk of adverse cardiovascular outcomes in diabetes patients[16]. The results are clearer after putting together the pieces, which are the association between lipid metabolism abnormalities and oxidative stress in cardiovascular disease, especially in diabetes patients.

Conclusion

This study has shown that lipid and oxyradical marker profiles are responsible for the development of myocardial infarction aggravated by diabetes. People with diabetes suffer from increased oxidative stress compared to individuals with myocardial infarction without any concomitant diabetes. Therefore, the presence of malondialdehyde, together with the fall in the activity of superoxide dismutase antioxidants, was obviously above the acceptable limit in MI patients suffering from diabetes and this imposes a bigger oxidative stress burden on them.

Therefore, what surfaced in these investigations is the complicated coordination between dyslipidemia and oxidative stress during the development of MI, especially in diabetic patients. The recommended therapeutic interventions that are tailored to improve dyslipidemia and mitigate oxidative stress, could hold the key to the management of this group of people, who are highly susceptible to developing cardiovascular morbidity and mortality. There is a need for clinical health improvement among such a population through specific therapeutic approaches adopted to correct the abnormalities in lipid metabolism and the management of cardiovascular morbidity and mortality.

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