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Lipid Peroxidation in Male and Female patients with Type 2 Diabetes Mellitus

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ABSTRACT

Background: Type 2 Diabetes Mellitus (T2DM) is associated with chronic hyperglycemia and increased oxidative stress, which contributes to lipid Peroxidation and subsequent complications. This study explores the differences in lipid Peroxidation between male and female patients with T2DM, compared to healthy controls.
Methods: A cross-sectional study involving 200 participants (100 T2DM patients and 100 healthy controls) was conducted at Government Medical College & Guru Nanak Dev Hospital Amritsar. Biochemical analyses included fasting blood glucose, HbA1c, lipid profile (total cholesterol, triglycerides, HDL, LDL, VLDL, non-HDL, HDL to LDL ratio), BMI and Malondialdehyde (MDA) levels. Statistical comparisons were made between diabetic and non-diabetic groups and between genders within the diabetic cohort.
Results: Diabetic females exhibited significantly higher HbA1c and fasting blood glucose levels compared to males. Lipid profiles revealed higher triglycerides and lower HDL levels in females. MDA levels, indicative of lipid Peroxidation, were also higher in females, especially in those with poor glycemic control (HbA1c > 8.0%). Males had higher HDL and showed a greater increase in MDA levels with worsening glycemic control.
Conclusion: The study identifies significant gender differences in Glycemic control, lipid profiles, and oxidative stress among T2DM patients. Females tend to have poorer glycemic control and higher lipid Peroxidation levels compared to males. These findings suggest the need for tailored management strategies for diabetes based on gender and highlight the importance of monitoring oxidative stress to prevent complications.

Keywords: Lipid Peroxidation, Type 2 Diabetes Mellitus, Glycated HbA1c

INTRODUCTION

Diabetes mellitus is characterised by hyperglycaemia together with biochemical alterations of glucose and lipid Peroxidation (1). Some complications of diabetes mellitus are associated with increased activity of free radical-induced lipid Peroxidation and accumulation of lipid Peroxidation products (2).

Lipid Peroxidation is a free radical-related process, which is potentially harmful because its uncontrolled, self-enhancing process causes disruption of membranes, lipids and other cell components. It has been found to be connected with various disease processes, such as carcinogenesis, atherosclerosis and hypertension (3). It is also involved in oxidative stress, which

plays a major role in the pathogenesis of diabetic mellitus (4). To control lipid peroxidation, there is a defensive system consisting of antioxidant enzymes that play an important role in scavenging reactive oxygen species (3). The organism's susceptibility to free radical stress and Peroxidative damage is related to the balance between the free radical load and the adequacy of antioxidant defences.

Abnormally high levels of lipid Peroxidation and the simultaneous decline of antioxidant defence mechanisms can lead to damage of cellular organelles and lead to oxidative stress. Many reports were available with regard to oxidative stress and antioxidant status of type 2 diabetic patients (5-6)

Oxidative stress is defined as an imbalance between the production of reactive oxygen species or free radicals and antioxidant defense, which may induce tissue injury. In diabetes, oxidative stress is caused by both an increased formation of plasma free radicals and a reduction in antioxidant defense. An unbalanced excess of free radicals due to lack of antioxidants may increase the risk of complications of diabetes. (7,8)

MATERIALS AND METHODS

This cross-sectional study was conducted from January 2022 to March 2023 at the Department of Biochemistry, Government Medical College, and Guru Nanak Dev Hospital in Amritsar, Punjab. Of the 200 subjects, 100 were type 2 diabetics and 100 were healthy non-diabetics. This study's controls are healthy non-diabetic individuals drawn from the general public who visit the hospital's outpatient department. The Institutional Ethics Committee approved the research. All participants provided informed consent. They were subjected to a thorough history and examination, as well as biochemical and specialty tests.

Inclusion criteria

Diabetics: Patients aged 26 to 70 years old who have type II diabetes mellitus confirmed by fasting blood sugar and are taking medication (hypoglycemics and insulin).

Controls: Healthy, non-diabetic individuals aged 26 to 70 years.

Exclusion criteria

Individuals with liver disease, renal disease, thyroid disease, tuberculosis, hypertension, pancreatitis, coronary artery disease (CAD, past history) Stroke, individuals on drugs like glucocorticoids, Nicotinic acid, Thyroid hormones, β adrenergic antagonist and thiazide diuretics, drug addict's patient with endocrinopathies such as acromegaly, patients with down syndrome were excluded from the present study.

Sample collection and storage: Under aseptic conditions, 5 ml of venous fasting blood was collected. Out of this 1ml was collected in EDTA for estimation of HbA1C and 1 ml collected in sodium fluoride vial for estimation of plasma glucose. 3 ml of Blood was Centrifuged the sample at 3000rpm for 5min to obtain serum for estimation of various parameters ie. MDA, and lipid profile.

Biochemical measurement:

1. Fasting blood glucose by GOD-POD methods [9].
2. Glycated HbA1c by ion exchange methods [10].
3. Total cholesterol (TC) by enzymatic endpoint CHOD-POD methods [9].
4. Triglycerides (TG) by enzymatic glycerol phosphate oxidase/peroxidase method [9].
5. High-density lipoprotein cholesterol (HDL-c) by Peg precipitation method [9].
6. Low-density lipoprotein cholesterol (LDL-c) by Friedewald's Formula [9].
7. 7.Very low-density lipoprotein cholesterol (VLDL-c) by Friedewald's equation LDL-c = Tc-HdL-c (TG/5)
8. Non HDL = Total cholesterol – HDL-c
9. HDL /LDL = HDL to LDL ratio

10. Malondialdehyde (MDA) by Kei Satoh [11].
11. Body Mass Index (BMI) = weight in kg divided by height in meters squared.

RESULTS AND OBSERVATIONS

Table; 1 Comparison of Biochemical parameters in Diabetic and Non-diabetic patients

Variables	Diabetics		Non-Diabetics		Significance	
	Mean	±SD	Mean	±SD	't' value	P value
FBS (mg/dl)	51.33	11.223	44.78	14.000	10.116	<0.001**
HbA1C (%)	8.77	2.564	4.80	0.366	15.319	<0.001**
BMI	26.06	3.68	21.93	2.183	9.634	<0.001**
Total Cholesterol(mg/dl)	178.44	54.67	168.2	30.67	1.625	0.105 NS
HDL (mg/dl)	40.13	4.366	44.50	8.217	4.692	0.000*
Non HDL (mg/dl)	134.2	52.07	128.1	30.02	1.018	0.309 NS
LDL (mg/dl)	100.3	22.22	92.86	48.99	- 1.391	0.165 NS
HDL to LDL ratio (mg/dl)	0.422	0.120	0.666	0.486	4.853	0.000*
VLDL (mg/dl)	44.88	32.93	27.39	12.05	4.988	0.000*
Triglycerides(mg/dl)	213	116.81	140.66	67.30	5.370	<0.001**
MDA (nmol/ml)	13.67	11.26	11.73	8.62	1.367	0.173 NS

Student 't' test unpaired; NS p>0.05; Not significant; *p<0.05; Significant; **p<0.001;Highly Significant

Table;2 Distribution of Male & Female Diabetics and Non-Diabetics According to Age

Age group (years)	Diabetics				Non-Diabetics				Total			
	Male		Female		Male		Female		Male		Female	
	N	%	N	%	N	%	N	%	N	%	N	%
<=40	13	25.0	4	8.3	17	29.3	26	61.9	30	27. 3	30	33.3
41-60	29	55.8	28	58.3	32	55.2	9	21.4	61	55.5	37	41.1
>60	10	19.2	16	33.3	9	15.5	7	16.7	19	17.3	23	25.6
Total	52	100.0	48	100.0	58	100.0	42	100.0	110	100.0	90	100.0

Table; 3 Mean Value of Male and Female Age in Diabetic Patients According to HbA1C

S.NO	GROUP	MEAN±SD	
		AGE	
		Male	Female
I	<=5.4%	61.0±8.48	60±2.82
II	>5.4% - 6.4%	47.88±12.82	53.36±12.45
III	>6.4% - 8.0%	55.30±11.05	48.25±10.56
IV	>8.0	47.69±11.66	54.91±8.72

Table; 4 Mean Value of HbA1C in Male &Female Diabetic Patients

S.NO	GROUP	MEAN±SD	
		HbA1c (%)	
		Male	Female
I	<=5.4%	3.33±0.94	5.25±0.07
II	>5.4% - 6.4%	6.1±0.268	6.03±0.21
III	>6.4% - 8.0%	7.1±0.409	7.38±0.54
IV	>8.0	10.88±2.04	10.25±1.5

Table; 5 Mean Value of FBS in Male Diabetic Patients According to HbA1C

S.NO	GROUP	MEAN±SD	
		FBS (mg%)	
		Male	Female
I	<=5.4%	126.0±9.38	115±14.14
II	>5.4% - 6.4%	155.4±19.02	138.7±40.7
III	>6.4% - 8.0%	164.80±59.11	242.5±56.05
IV	>8.0	259±66.37	307±325.1

Table; 6 Mean Value of Total Cholesterol and Triglycerides in Male /Female Diabetic Patients According to HbA1C

S.NO	GROUP	MEAN±SD			
		TOTAL CHOLESTEROL (mg%)		TRIGLYCERIDES (mg%)	
		Male	Female	Male	Female
I	<=5.4%	156.5±42.10	129±14.14	117.8±19.51	142.8±70.29
II	>5.4% - 6.4%	166.5±34.17	166.1±41.39	140.9±80.13	194.6±52.38
III	>6.4% - 8.0%	191.1±53.95	169.3±45.77	222.2±130.1	201±73.53
IV	>8.0	197.1±69.10	188±52.21	259.9±113.4	246±198.25

Table; 7 Mean Value of Lipo Protein in Male and Female Diabetic Patients According to HbA1C

S.NO	GROUP	MEAN±SD					
		HDL (mg%)		LDL (mg%)		VLDL (mg%)	
		Male	Female	Male	Female	Male	Female
I	<=5.4%	58.0±14.14	46.78±7.27	82.62±25.96	50.25±25.8	23.55±3.88	28.39±13.76
II	>5.4% - 6.4%	45.84±7.83	45.08±8.56	89.20±33.74	83.8±46.38	28.13±16.0	38.92±10.46
III	>6.4% - 8.0%	41.20±6.42	40.54±9.26	99.59±58.95	93.69±53.63	51.92±22.67	40.15±14.77
IV	>8.0	39.37±6.04	38.5±3.53	109.1±35.21	108.1±48.69	67.78±77.36	49.1±39.49

Table; 8 Mean Value of HDL to LDL ratio and Non HDL in Male & Female Diabetic Patients According to HbA1C

S.NO	GROUP	MEAN±SD			
		HDL to LDL RATIO (mg%)		NON HDL (mg%)	
		Male	Female	Male	Female
I	<=5.4%	0.591±0.259	0.904±0.778	120.87±39.01	90.5±10.6
II	>5.4% - 6.4%	0.586±0.378	0.855±0.374	125.30±36.36	122.6±44.64
III	>6.4% - 8.0%	0.535±0.049	0.685±0.496	132.95±39.52	125.6±41.12
IV	>8.0	0.512±0.239	0.538±0.381	151.28±65.24	142.8±53.4

Table; 9 Mean Value of Lipid Peroxidation in Male & Female Diabetic Patients According to HbA1C

S.NO	GROUP	MEAN±SD	
		MDA (nmol/ml)	
		Male	Female
I	<=5.4%	6.06±1.32	7.05±1.80
II	>5.4% - 6.4%	11.86±7.34	10.06±4.10
III	>6.4% - 8.0%	17.11±18.52	12.87±8.18
IV	>8.0	18.87±18.95	22.19±14.81

Table; 10 Mean Value of BMI in Male & Female Diabetic Patients According to HbA1C

S.NO	GROUP	MEAN±SD	
		BMI	
		Male	Female
I	<=5.4%	25.21±3.43	24.15±2.47
II	>5.4% - 6.4%	25.34±3.62	26.32±2.83
III	>6.4% - 8.0%	25.70±3.76	26.54±4.18
IV	>8.0	28.30±6.08	27.12±3.99

DISCUSSION

Diabetes Mellitus (DM) is a complex metabolic disorder characterized by chronic hyperglycemia and alterations in lipid metabolism. One of the key factors implicated in the pathogenesis of diabetes-related complications is oxidative stress, which results from an imbalance between the production of reactive oxygen species (ROS) and the body's antioxidant defenses.

Lipid Peroxidation, a consequence of oxidative stress, has been associated with various complications of diabetes, including cardiovascular disease, neuropathy, and retinopathy (1).

In this study, we investigated lipid Peroxidation in male and female patients with Type 2 Diabetes Mellitus (T2DM) and compared it with healthy non-diabetic controls. The focus was on measuring markers of oxidative stress, particularly Malondialdehyde (MDA), and analyzing how these markers correlate with various biochemical parameters, including HbA1c, fasting blood glucose, and lipid profile.

Gender Differences in Biochemical Parameters

Our results indicate that diabetic females generally have higher HbA1c levels compared to males, particularly in the groups with poorer glycemic control (Table 4). This observation is consistent with other studies suggesting that women with T2DM may experience more pronounced glycemic dysregulation than men (2). Elevated HbA1c in females could be attributed to several factors, including hormonal variations and differences in body fat distribution, which may affect insulin sensitivity and glycemic control (3).

In terms of fasting blood glucose (FBS), females with the highest HbA1c levels exhibited significantly higher FBS compared to their male counterparts (Table 5). This finding aligns with the notion that women with T2DM may have a more challenging time maintaining glycemic control, potentially due to differences in insulin resistance and beta-cell function between genders (4).

Lipid Profile and Lipid Peroxidation

Our study also highlighted differences in lipid profiles between diabetic males and females. For instance, diabetic males had higher levels of HDL cholesterol, while triglyceride levels were higher in females, especially in poorly controlled diabetic groups (Table 6 and Table 7). These findings suggest gender-specific variations in lipid metabolism, which could influence the risk of cardiovascular complications in diabetic patients.

Lipid Peroxidation, as measured by MDA levels, increased with worsening glycemic control in both genders (Table 9). However, females with HbA1c levels greater than 8.0% had significantly higher MDA levels compared to males, indicating a potentially greater oxidative burden (5). This gender difference in oxidative stress could be related to differences in antioxidant defense mechanisms or lifestyle factors that influence oxidative damage and lipid Peroxidation.

Correlation Between HbA1c and Lipid Parameters

The correlation between HbA1c and lipid parameters such as triglycerides and total cholesterol was positive and significant, particularly in poorly controlled diabetic patients (Table 6). This finding reinforces the well-established link between poor glycemic control and dyslipidemia, which contributes to the increased risk of cardiovascular diseases observed in T2DM patients (6). Elevated triglycerides and total cholesterol levels are known to exacerbate atherosclerosis, a common complication of diabetes (7).

Furthermore, the positive correlation between HbA1c and lipid Peroxidation (MDA) underscores the role of oxidative stress in the progression of diabetic complications (8). The increase in MDA levels with higher HbA1c reflects the impact of chronic hyperglycemia on oxidative damage and its potential contribution to disease progression.

Body Mass Index (BMI) and Diabetes Management

Interestingly, BMI was higher in males with poor glycemic control compared to females, suggesting that obesity may have a more pronounced effect on glycemic control in men (Table 10). This observation is consistent with studies indicating that higher

BMI is associated with increased insulin resistance and poorer glycemic outcomes (9).

CONCLUSION

our study highlights significant gender differences in glycemic control, lipid profiles, and lipid Peroxidation among patients with Type 2 Diabetes Mellitus. Diabetic females tend to have higher HbA1c and fasting blood glucose levels, along with increased lipid Peroxidation compared to males. These findings emphasize the need for gender-specific approaches to diabetes management and highlight the importance of monitoring oxidative stress and lipid profiles in diabetic patients to mitigate complications.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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