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ORIGINAL RESEARCH

An Interconnection of Biomarkers in Correlation to Body Mass Index (BMI) and Lipid Peroxidation In Type 2 Diabetes Mellitus Patients

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ABSTRACT

Background: Body mass index (BMI) is a traditional measurement practice that divides a person's weight by their height to find out whether they have a healthy range of weight. The objective of this study is to understand the relation between BMI and prevalence of diabetes mellitus, hypertension, and dyslipidemia. **Material and Method:** The distribution of Body Mass Index (BMI) among this cohort of patients was analyzed in relation to the presence or absence of hypertension and dyslipidemia. The improper secretion of insulin results in alterations in the metabolism of lipids, proteins, and carbohydrates. This condition is also characterized by hyperglycemia and is commonly referred to as diabetes mellitus (DM). **Results:** Excessive free radicals cause oxidative stress, weakening the body's antioxidant defense system. This can lead to diabetic disorders and an increase in malondialdehyde (MDA) production. In cells, the breakdown of polyunsaturated fatty acids is seen as a key indicator and result of oxidative stress. **Conclusion:** This study found that individuals with diabetes had a higher Body Mass Index (BMI) than those in a control group. There was also a strong link between glycated hemoglobin, cholesterol, and MDA levels. To prevent and manage complications in type 2 diabetes, it is crucial to keep MDA and body weight at normal levels. More extensive studies are needed to confirm these findings.

Key Words: Body Mass Index, Type 2 Diabetes Mellitus, Lipid Peroxidation, Oxidative Stress, Free Radicals Malondialdehyde

INTRODUCTION

Diabetes mellitus (DM) is recognized as a metabolic disorder whose prevalence is escalating at an alarming rate across the globe.[1] Over the past three decades, patients with diabetes mellitus have experienced a significant transformation in their health status, shifting from being perceived as a mild affliction primarily among the elderly to now posing a substantial cause of morbidity and mortality among youth and middle-aged individuals.[2] Type I diabetes is distinguished by hyperglycemia alongside dysregulation in both the secretion and functionality of endogenous insulin.[3] The phenomenon known as global concern, type II diabetes, manifests gradually through the onset of insulin resistance and, over time, culminates in the body's inability to sustain glucose homeostasis.[4] The immune system operates in a systematic fashion to maintain homeostasis, thereby facilitating the attainment of a disease-free condition. Under specific conditions, there is an elevated production of free radicals, which leads to oxidative stress and lipid peroxidation.[5] The complexities associated with diabetes, including diabetic ketoacidosis, nephropathy, neuropathy, and both micro- and macro-vascular complications, manifest as a result of elevated formation of reactive oxygen species (ROS).[6] Lipid peroxidation contributes significantly to the pathogenesis of various degenerative disorders, including atherosclerosis, diabetes, and carcinogenesis.[7] Lipid peroxidation

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commences with the fatty acyl side chain or fatty acid of a chemical species, resulting in the abstraction of a hydrogen atom from a methylene carbon within the side chain. The removal of this hydrogen atom is considerably more facile in polyunsaturated fatty acids, rendering them particularly vulnerable to peroxidation.[8, 9]

This research aims to assess oxidative stress through the measurement of malondialdehyde (MDA) and body mass index (BMI), alongside other parameters, in individuals with type II diabetes, both with and without complications. To establish a correlation between BMI and MDA levels in individuals with diabetes, and to ascertain whether serum levels of MDA and BMI can be anticipated based on the values observed in both groups.

MATERIAL AND METHODS

The study encompassed a cohort of 120 type 2 diabetic patients, aged between 40 and 60 years, representing both genders, who were receiving oral hypoglycemic medications and presented as outpatients at Government Medical College, Jalaun (Orai), and Autonomous State Medical College, Lalitpur, Uttar Pradesh. The disordered diabetic patients were categorized into two distinct groups based on the presence or absence of comorbidities, including hypertension, thyroid disorders, and vascular complications. Group I comprised patients with no history of additional diseases, while Group II included those who exhibited other diseases and vascular complications. A cohort of 60 healthy individuals matched by group and gender was designated as the control group. Approval from the Institutional Ethical Committee was obtained prior to the commencement of the study. The experiments were conducted in compliance with the principles established by the Helsinki Declaration of 1975. Blood samples for fasting analyses were systematically procured shortly following participant enrollment in the study. The samples underwent centrifugation for duration of 10 minutes at a speed of 2000 rpm. Additionally, fasting blood glucose levels and associated lipid profile parameters, including total cholesterol and triglycerides, were assessed utilizing an automatic analyzer. Employing the ion exchange resin technique alongside the thiobarbituric acid reactive substances assay, both Glycated Hemoglobin (HbA1c) and serum Malondialdehyde (MDA) levels were determined, respectively.[10] Statistical analyses were conducted utilizing the SPSS 20.0 software. The statistically significant values were assessed using the mean ± standard deviation, $P<0.05$. The generally distributed data were analyzed utilizing one-way analysis of variance. The Pearson correlation test was employed to perform the correlation analysis.

RESULTS

The comparative analysis of the baseline characteristics in the three groups – control (n=60), type 2 DM without complications (n=60) and those with complications (n=60). The subjects exhibit similarity with respect to age, gender, body mass index, and waist-to-hip ratio. The BMI of group I (p value<0.05) and group II (p value <0.001) is statistically significant while comparing with control group. Similarly, waist and hip ratio of group I and group II are statistically significant (p value<0.5). Table no 1 is showing the comparative analysis of the baseline characteristics in the three groups – control (n=60), type 2 DM without complications (n=60) and those with complications (n=60).

Table No.1: The comparative analysis of baseline characteristics between the control group and the type 2 diabetes mellitus (DM) groups

	Control group (n=60)	Group I type 2 DM patients without complications (n=60)	Group II type 2 DM patients with other complications (n=60)
Age	46.8±4.2	47.2±4.9	48.4±4.6
Male	46 (76.7%)	48 (80%)	51 (85%)
Female	14 (23.3%)	12 (20%)	9 (15%)
BMI (Kg/m2)	23.6±1.514	28.21±1.621 (p<0.05)	29.4±2.624 (p<0.001)
Waist and Hip ratio	0.902±0.35	0.931±0.031 (p<0.05)	0.935±0.026 (p<0.05)

The biochemical parameters across the three designated groups are comparatively analyzed as mentioned in table no.2. All six parameters are observed to be at their lowest levels in the control group. Furthermore, these parameters present at elevated levels in patients with type 2 diabetes mellitus (DM) that experience complications, in comparison to those without complications.

Table No.2: The comparison of biochemical parameters between control and type 2 diabetes mellitus (DM) groups

	Control group (n=60)	Group I type 2 DM patients without complications (n=60)	Group II type 2 DM patients with other complications (n=60)
FBG (MG/DL)	89.68 ±7.83	132.6 ± 23.28^{a*}	142.8± 41.82$^{a*b\#}$
PPBG (MG/DL)	106.86±7.851	162.8±10.62^{a*}	194.2±19.21 ^{a*b*}
HbA1c	5.6±0.4	7.6±0.62^{a*}	8.9±0.5 ^{a*b*}
Cholesterol (mg/dl)	113.1±7.942	192.3±21.69^{a*}	216.4±16.4 $^{a*b\#}$

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TG (mg/dl)	98.85±12.26	172.3±16.82 [a*]	192.5±17.2[a*b*]
MDA (nmole/dl)	61.24±2.867	92.6±11.01	118.6±13.42 [a*b*]
[a]Controls versus Group I type 2 DM, Group II type 2 DM, [b]Group I type 2 DM versus Group II type 2 DM, [*]P<0.001, [#]P<0.05, and P<0.05 are statistically significant, DM: Diabetes mellitus			

The correlation coefficient between biochemical parameters in patients who have type 2 diabetes mellitus is presented in Table 3. At the 0.05 level of statistical significance, all of them are deemed to be significant, and three of them (HbA1c, Cholesterol, and MDA) are considered to be significant at the 0.01 level of statistical significance.

Table No.3: The comparative analysis between BMI and measured parameters in type II Diabetes mellitus patients

Parameter	Coefficient (r) of correlation
FBG	0.79*
PPBG	0.261*
HbA1c	0.504**
Cholesterol	0.372**
TG	0.249*
MDA	0.392
**Correlation is significant at 0.01 levels (two tailed). *Correlation is significant at 0.05 level (two tailed),	

DISCUSSION

The vascular complications and various multifactorial determinants corroborate the elevated incidence of type 2 diabetes mellitus (DM).[11,12] Within the scope of the current study, parameters such as lipid profile, fasting plasma glucose (FPG), postprandial glucose (PPG), glycosylated hemoglobin (HbA1c), in conjunction with the waist-hip ratio and body mass index (BMI), exhibit a marked increase among patients with type 2 diabetes compared to healthy control subjects. The factors previously observed are more prevalent in Group II subjects compared to Group I. It was observed that diabetic patients exhibited a significantly higher Body Mass Index (BMI) in comparison to the control group. It was additionally observed that the aforementioned increase in BMI is correlated with levels of HBA1c, cholesterol, and MDA. The increase in both visceral adiposity and obesity contributes to the exacerbation of insulin resistance in individuals with type 2 diabetes. Obesity leads to an accumulation of excess adipose tissue, which subsequently diminishes glucose utilization and chronically elevates circulating fatty acids.[13] Additionally, factors such as lifestyle, occupational environment, environmental influences, and hereditary components contribute to the proliferation of adipose tissue. The studies elucidate that a decrease in glucose utilization occurs when adiposity surpasses threshold levels, resulting in an elevation of circulating fatty acids.[14,15] In the current study, it was observed that malondialdehyde (MDA) levels exhibited a significant increase in participants classified under Group II with diabetes compared to those in Group I. Moreover, the concentration of malondialdehyde (MDA) was higher in patients with diabetes in comparison to healthy individuals. Research indicates that the Amadori rearrangement contributes to elevated levels of free radicals in individuals with hyperglycemic diabetes, thereby enhancing the likelihood of additional diabetic complications such as diabetic retinopathy and cardiomyopathy, among others.[16] The antioxidants within the human body mitigate reactive oxygen species (ROS), consequently diminishing cellular damage.[17] The pathogenesis of diabetes is reported to escalate in conjunction with increased oxidative stress.[18] The generation of ROS is facilitated by various factors including Fenton reactants, advanced glycation end products, mitochondrial respiratory chain deficiencies, glucose oxidation, and several enzymatic and non-enzymatic sources.[19] The accelerated rate of lipid peroxidation coupled with diminished cellular antioxidant mechanisms establishes a pathogenic association between hyperglycemia and the progression of complications in patients with type 2 diabetes mellitus.[20]

CONCLUSION

This research demonstrates a positive correlation between Body Mass Index (BMI) and Malondialdehyde (MDA). The findings suggest that the monitoring of malondialdehyde (MDA) levels, coupled with a reduction in body weight, may be beneficial in delaying the onset of vascular complications associated with type 2 diabetes mellitus (DM). Additional research involving a larger sample size is necessary to substantiate these findings.

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