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Evaluation of the adrenomedullin, ferritin and some biochemical parameters in type 2 diabetes patients

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Diabetes mellitus is a clinical syndrome characterized by a high level of glucose in the blood resulting from a defect in insulin secretion or insulin action or both, which causes an imbalance of glucose utilization in tissues and glucose release by the liver . A biochemical study was conducted to assess the level of adrenomedullin and some biochemical variables had 140 blood samples for men, including four groups per group 35 samples, (G1) group 2 DM, (G2) 2 DM with hypertension, DM(G3)2 with renal failure and the control group. Their ages range between 30-70 years. Patient samples were collected from Samarra General Hospital and outpatient clinics between 20/12/2020 to 20/4/2021. The current study approached the evaluation of the concentration of adrenomedullin, ferritin, glucose, urea, creatinine, glutathione and malondialdehyde, Hba1c .The results showed a significant increase (P≤0.05) in the level of adrenomedullin in G1, with a decrease in G2 and G3 compared with the control group, and the level of ferritin increased significantly in G1, G2 and G3 compared with the control group, while the results indicated a significant decrease in the level of GSH in G1, G2, and G3 compared with the control group. The level of MDA significantly increased in G1, G2 and G3 compared with the control group. Further, the level of glucose significantly increased in G1, G2 and G3 compared with the control group, and the concentration of Hba1c increased significantly in G1 and G2, while G3 did not show any significant differences compared with the control group. The level of urea increased significantly in G2 and G3, while G1 did not show any significant differences compared with the group. And creatinine level increased significantly in G3, while G1 and G2 did not show any significant differences in comparison to the control group .From the current study, we concluded that diabetes, hypertension, and kidney disease had a clear effect on biochemical parameters and increased oxidative stress.

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KEYWORDS

Type 2 diabetes mellitus; adrenomedullin ferritin; oxidative stress; antioxidant.

Introduction

Diabetes is characterized by hyperglycemia, which results from a defect in insulin secretion or its resistance. Diabetes causes retinopathy, neuropathy, nephropathy, and atherosclerosis. These complications are the results of prolonged hyperglycemia [1]. Type 2 non-insulin dependent diabetes mellitus (NIDDM) is the most common and mildest type of diabetes, involving 90% of people with

diabetes worldwide. It usually appears after the age of 40, which is why it is called adult diabetes [2]. It emerges as the cells of the body become less responsive to the action of insulin, and the muscles and fat tissues are unable to use insulin appropriately, or sometimes the pancreas does not produce enough insulin for the body's needs, so this type of disease is characterized by the presence of insulin accompanied by a defect, either with a deficiency of its secretion from the pancreas or a defect in its receptors, which leads to an uncontrolled glucose level in the blood [1,2].

Adrenomedullin (ADM) is a peptide hormone consisting of 52 amino acids belonging to the peptide family of the calcitonin gene related peptide (CGRP) [3]. It was first detected in human pheochromocytoma tissue by Kitamura in 1993 by monitoring elevated cyclic adenosine monophosphate (cAMP) in human platelets [4]. ADM is synthesized both from the atria and ventricles of the heart and blood vessels. It is actively synthesized and secreted by vascular and endothelial smooth muscle cells [5]. Besides, the hormone is synthesized in the lung [6] and brain as well as in the islets of the pancreas [7]. Plasma ADM level in healthy subjects is low and its level changes to compensate for the vasoconstrictor effects. The increase in the ADM level in plasma correlates with the diseases' state severity. For example, an elevated plasma ADM level has been associated with heart failure, hypertension, atherosclerosis, and diabetes [8]. ADM inhibits insulin secretion after oral administration of glucose. Therefore, it is expected to contribute to diabetes mellitus (DM) and even lead to the development of diabetes complications [9]. There has been progress in understanding the relationship between adrenomedullin and diabetes.

The plasma level of the hormone is elevated in patients with poorly controlled diabetes, indicating a direct effect of glucose on hormone secretion [8,9].

Oxidation contributes to the occurrence of many diseases such as high blood pressure, Alzheimer's disease, Parkinson's disease [10,11], autoimmune disorders [12] and cancer [13]. Hyperglycemia promotes oxidative stress through the production of free radicals and the elimination of antioxidants [14], as in cases of chronic hyperglycemia, the reactive oxygen species (ROS) production is permanent, and therefore it acts to remove enzymatic and non-enzymatic antioxidants from various tissues [15].

Malondialdehyde (MDA) is one of the end products of the oxidation process of unsaturated fatty acids (lipid peroxidation), and consists of three carbon atoms with two aldehyde groups [16], it is one of the indicators used to know the presence of the oxidation process within the tissues of the body [17]. Glutathione (GSH) (γ-glutamyl-cysteinylglycine) is a major intracellular antioxidant that plays a key role in reducing the effects of oxidative stress and thus inhibiting ROS, resulting in the repair of damaged cells' [18].

Ferritin (FRT) is a globular protein complex consisting of 24 Subunit (subunit) as these units represent the cells of the protein iron essential in both prokaryotes and eukaryotes and keep iron in a soluble and non-toxic form [19]. Iron is found in greater proportion in the bone marrow, liver and spleen [20]. FRT stores are positively associated with the development of glucose intolerance, and type 2 diabetes [21]. The aim of this study was to evaluate adrenomedullin, ferritin with some biochemical parameters in patients.

Material and method

Sample collection and study design: Group 1 (G1) involves 35 samples for type 2 diabetes patients; group 2 (G2) involves 35 samples for type 2 diabetes with high blood pressure; group 3 (G3) involves 35 samples for patients with type 2 diabetes with renal insufficiency

and 35 samples for the healthy individuals as control group. Their age ranged from 30-70 year. Patients samples were collected from Samarra General Hospital and outpatient clinics, as well as Tikrit Hospital from the period between 20/12/2020 to 20/4/2021.

Blood collection

After 10 hours of fasting, the blood was drawn and left at room temperature for coagulation and for 10 min., the serum was expelled at 4000 x g and the separated sera were frozen at -20 °C for future biochemical analysis.

Biochemical parameters analyses

Adrenomedullin concentration was measured by Enzyme Linked Immune-Sorbent Assay (ELISA) method, the ELISA kit provided by Melsin Medical, China. Ferritin's concentration was determined by ELISA, provided by Monobind Inc-USA, Glycated hemoglobin (HbA1c) from Stan Bio America company. Blood sugar, urea, creatinine levels were determined according to enzymatic method using the colorimetric method according to the kit procedure provided by Bio Maghreb.

Statistical analysis

Applying the SPSS statistical program, Duncan's multinomial test was used to compare the chemical variables between four groups at the level of probability ($P \leq 0.05$).

Results and discussion

The present study delved into the determination of the levels of ADM, FRT, GSH and MDA in the serum of patients in four groups. The results obtained from this study are summarized in Table 1.

TABLE 1 Mean ± SD of ADM, FRT, GSH and MDA in four groups under investigation

Groups	ADM pg/ml	FRT ng/ml	GSH mmol/L	MDA mmol/L
Control	161.379±21.758 b	50.187±12.918 b	10.345±1.135 a	6.795±1.566 c
G1	182.508±13.034 a	123.867±31.446 a	7.101±1.077 d	16.811±4.054 a
G2	53.308±13.034 c	119.975±29.427 a	8.768±0.695 c	13.375±2.247 b
G3	35.775±15.981 d	114.191±26.206 a	9.236±0.583 b	15.396±4.021 a

Different letters indicate statistically significant differences, while similar letters do not have statistically significant differences.

Adrenomedullin level

Table 1 shows the mean ± SD of AMD level (182.508±13.034) pg/mL in G1, (53.308±13.034) pg/mL in G2, (35.775±15.981) pg/mL in G3 and (161.379±21.758) pg/ml in the control group. The results indicated that the level of AMD in the blood significantly increased ($P \leq 0.05$) in G1, while it decreased in G2 and G3 compared with the control group, as seen in Figure 1.

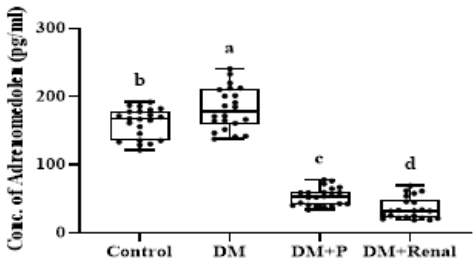

FIGURE 1 Concentration of AMD in groups

The level of ADM significantly increased in the group of diabetes patients (G1), which is in agreement with the Nakamura's study

reporting that the level of the hormone in plasma was elevated in type 2 diabetes, but it is not related to the level of glucose in the blood circulation [22].

As the level of the hormone in healthy individuals is low, its level changes to compensate for the vasoconstrictor effects. An increased level of ADM in plasma correlates with the severity of the disease states. Elevated plasma ADM levels cause heart failure, hypertension, atherosclerosis, and diabetes [23], and ADM plasma levels in type 2 diabetes patients are associated with a broader set of complications. The elevation may be attributed to acute hyperinsulinemia, oxidative stress and endothelial damage, which increase ADM production from pancreatic islets and vascular endothelium. This elevation may represent an etiological factor that leads to disease onset and insulin resistance [24].

ADM also inhibits insulin secretion after oral administration of glucose; therefore, it can be expected that ADM contributes to diabetes and even leads to the development of complications of diabetes [25]. As the cells of the body become less responsive to the action of insulin and the muscles are unable to use insulin appropriately, or the pancreas sometimes does not produce enough insulin for the body's need, this type of disease is characterized by the presence of insulin accompanied by a defect, either due to a lack of pancreatic secretion or a defect in its receptors, which leads to not controlling the level of glucose in the blood. There has been progress in understanding the relationship between ADM and diabetes. The plasma level of the hormone is elevated in patients with poorly controlled diabetes in normal subjects, indicating a direct effect of glucose on hormone secretion [26].

The level of the hormone decreased in groups G2 and G3 and this is contrary to a study that found a positive association between the level of ADM in plasma and average blood pressure. Previous research has also shown an increase in plasma ADM level in patients with hypertension and chronic renal failure, especially an elevated plasma ADM level, a 3-fold increase associated with renal failure. Elevation in ADM may help prevent increased blood pressure and body fluid retention and represents a compensatory mechanism for diabetes complications [27].

Ferritin level

Table 1 shows the mean ± SD of FRT level (123.867±31.446) ng/ml in G1, (119.975±29.427) ng/ml in G2, (114.191±26.206) ng/ml in G3 and (50.187±12.9) ng/ml in the control group.

The results indicated that the level of FRT in the blood increased significantly (P≤0.05) in G1, G2 and G3 compared with the control group, while there were no significant differences between the groups G1, G2 and G3, as seen in Figure 2.

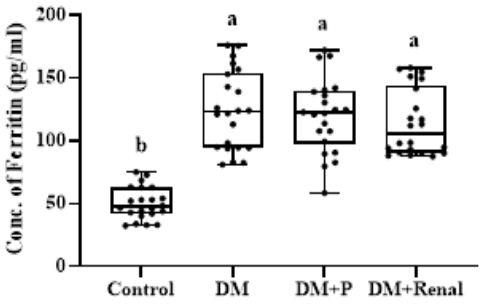

FIGURE 2 concentration of FRT in groups

The concentration of FRT significantly increased in all groups, where it increased significantly in G1 compared with the healthy group and in agreement with the results of Sumesh et al. [28], proving the existence of a relationship between FRT and type 2 diabetes, on which many studies indicate that the iron content plays a role in causing type 2 diabetes, as iron is a strong oxidizing factor, and high iron content is accompanied by an increase in the level of oxidizing factors that may raise the risk of type 2 diabetes. There are several epidemiological studies that give a positive report on the relationship between increased iron storage, which represents ferritin, and an

increased risk of type 2 diabetes [29]. Recently, an association has been made between iron excess through iron-containing foods, such as red meat, and increased iron stores, and the development of diabetes, and it is suggested that there is a link between iron excess and improved insulin resistance and secretion [30,31].

GSH level

Table 1 shows the mean ± SD of GSH level (7.101±1.077) mmol/L in G1, (8.768±0.695) mmol/L in G2, (9.236±0.583) mmol/L in G3 and (10.345±1.135) mmol/L in the control group. The results displayed that the GSH level in the blood significantly decreased (P≤0.05) in G1, G2 and G3 compared to the control group, as seen in Figure 3.

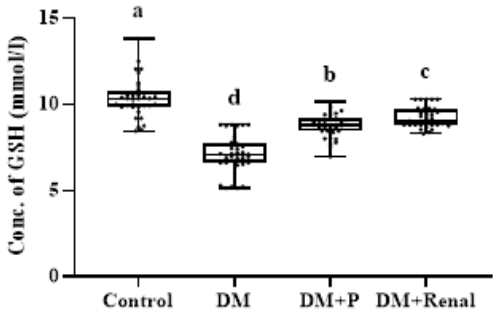

FIGURE 3 Concentration of GSH in groups

The results indicated that the level of GSH significantly decreased in all groups, as the results showed that patients with type 2 diabetes had lower concentrations of GSH in plasma and higher concentrations for non-diabetics or the control group. So, our study is similar to other studies [32,33], demonstrating GSH deficiency in type 2 diabetes. However, we also observed that GSH concentrations and synthesis rates were lower in diabetic patients with known microvascular complications compared with the data from the control group showing that rates of GSH synthesis and possibly increased permanent use of GSH contribute to its lower concentration in type 2 diabetes. Chronic hyperglycemia also leads to the development of microvascular complications [34], and increases the risk of vascular disease [35]. Cellular damage from hyperglycemia leads to oxidative stress, i.e., increased superoxide production through a number of mechanisms including increased formation of advanced glycation end products, polyol pathway activity, hexosamine activity, and protein kinase C activation [34,36]. Intensive glycemic control reduces the incidence of microvascular complications [34]. Since lowering blood glucose reduces oxidative stress [37,38], the reduced risk of microvascular complications may be in part due to improved antioxidant capacity. Since GSH is a major antioxidant within cells, it plays a key role in reducing the effects of oxidative stress [39].

MDA level

Table 1 shows the mean ± SD of MDA level (16.811±4.054) mmol/L in G1, (13.375±2.247) mmol/l in G2, (15.396±4.021) mmol/l in G3 and (6.795±1.566) mmol/l in the of the control group. The results displayed that the level of MDA in the blood increased significantly (P≤0.05) in G1, G2 and G3 compared with the control group, while there were no significant differences between the two groups G1 and G3, as seen in Figure 4.

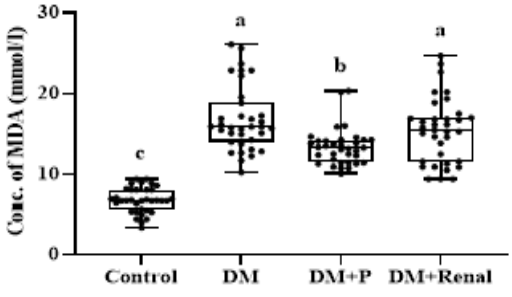

FIGURE 4 Concentration of MDA in groups

The levels of MDA increased in the groups under study and that the level of MDA increased significantly in the G1 group; this is in agreement with the results of Al Samarrai [40], which indicated an elevated level of MDA in the type 2 diabetes patients. The results of the current study agree with those of Humadi

et al. [41], which revealed that diabetes patients had a very high MDA level. A high level of MDA is an indicator of a high state of oxidative stress in the body, and the MDA level increases and its concentration is associated with an increase in the blood glucose level in patients with diabetes. Aldehyde dehydrogenase enzymes act in the liver mitochondria due to the increased concentration of fats in the tissues and these enzymes work to remove oxidized fats from the tissues [42,43].

The current study also included the determination of the levels of glucose, Hba1c, urea and creatinine in the serum of patients in four groups. The results obtained from this study are summarized in Table 2.

TABLE 2 Mean ± standard deviation of serum FSG, Hba1c, urea and creatinine in groups under investigation

Groups	Glucose mg/dl	Hba1c %	Urea mg/dl	Creatinine mg/dl
Control	81.54±15.13 c	5.50±0.44 b	26.26±5.35 c	0.85±0.14 b
G1	175.82±43.61 a	9.76±1.81 a	30.37±6.19 c	0.97±0.17 b
G2	192.48±46.81 a	9.18±1.75 a	38.65±9.15 b	1.16±0.37 b
G3	132.60±41.85 b	5.51±0.94 b	119.88±32.81 a	7.11±1.62 a

Different letters indicate statistically significant differences, while similar letters do not have statistically significant differences

Glucose level

Table 2 shows the mean ± SD for glucose level (175.82 ± 43,61) mg/dl in G1, (192.48 ± 46.81) mg/dl in G2, (132.60 ± 41,854) mg/dl in serum G3 and (81.54 ± 15.13) mg /dl in the control group. The results indicated that the blood glucose level significantly increased (P≤0.05) in G1, G2 and G3 compared with the control group, with no significant difference between G1 and G2 despite the slight increase in glucose level in G2 compared with G1 (Figure 5).

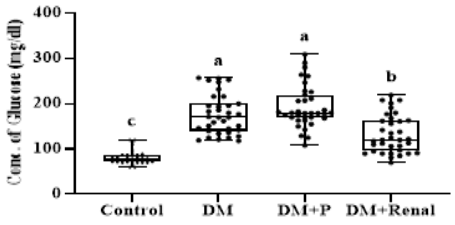

FIGURE 5 Concentration of glucose in groups

The level of glucose increased in the groups under experiment, as our results showed a significant increase in the G1 group, in agreement with the results of Farhan study [44].

Hba1c level

Table 2 shows the mean Hba1c ± SD estimate of the glycosylated hemoglobin level (9.76 ± 1.81) in G1, (9.18 ± 1.75) in G2, (5.51 ± 0.94) in serum G3 and (5.50 ± 0.44) in the control group. The results indicated that the level of Hba1c in the blood significantly increased (P≤0.05) in G1 and G2, while G3 did not show any significant differences compared with the control group, and with no significant difference between G1 and G2 in the level of Hba1c as represented in Figure 6.

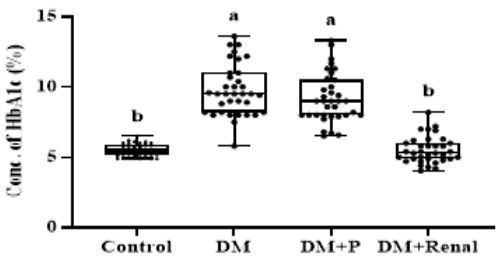

FIGURE 6 concentration of Hba1c in groups

Glycated hemoglobin concentration increased significantly in the G1 and G2 groups, coinciding with the increase in the serum glucose concentration in type 2 diabetic patients compared with the healthy controls. These results agree with those of Al-Mayah *et al*. [45].

Urea level

Table 2 shows the mean ± SD of serum urea level (30.37±6.19) mg/dl in G1, (38.65±9.15) mg/dl in G2, (119.88±32.81) mg/dl in G3 and (26.26±5.35) mg/dl in the control group. The results displayed that the level of urea in the blood significantly increased (P≤0.05) in G2 and G3, while G1 did not show any significant differences compared with the control group, despite the presence of a high presence between G1 and control (Figure 7).

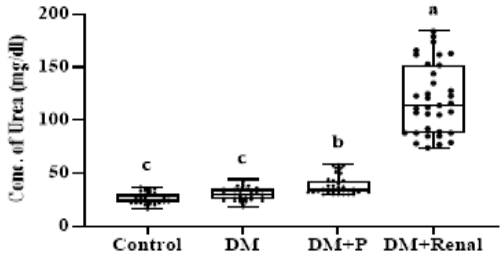

FIGURE 7 Concentration of urea in the groups

There is no significant effect of urea concentration in the G1 group, as the diabetes group, but the concentration of urea rises in hypertensive patients G2 and G3 groups.

Creatinine level

Table 2 shows the mean ± SD of creatinine level (0.97±0.17) mg/dl in G1, (1.16±0.37) mg/dl in G2, (7.11±1.62) mg/dl in G3 and (0.85±0.14) mg/dl in the of the control group. The results indicated that the level of creatinine in the blood significantly increased (P≤0.05) in G3, while G1 and G2 did not show any significant differences compared with the control group (Figure 8).

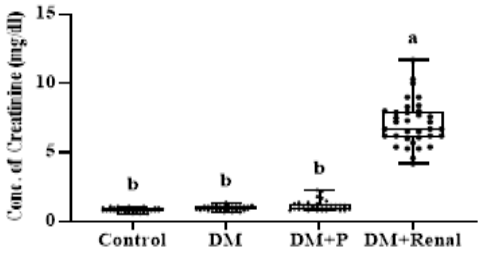

FIGURE 8 Concentration of creatinine in the groups

The results did not show any significant differences between the groups G1 and G2 compared with the control group, while the G3 group showed a significant increase, being in agreement with the study by Rakopersingh *et al*. [46].

Conclusion

From this, adrenomedullin level was increased in G1, with a decrease in G2 and G3, and the ferritin level was increased significantly in G1, G2 and G3 compared with the control. Results showed increase the oxidative stress and decrease the antioxidants, increase the concentrations of urea and creatinine, we concluded that diabetes, hypertension, and kidney disease had a clear effect on biochemical parameters and increased oxidative stress.

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