



Study of Thyroid Dysfunction and Serum Electrolytes Levels in Diabetes Mellitus Patients

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ABSTRACT

Diabetes Mellitus is a group of metabolic diseases characterized by hyperglycemia and metabolic disturbances of various metabolisms of Carbohydrates and majorly caused by the Dysfunction of Beta cells in the pancreas. It is of increasing concern, in which a person will have a hyperglycemia, because of the body does not produce enough insulin or because the cells in the body does not respond to the insulin that is produced, majorly, diabetes have been classified into three types. Type I diabetes mellitus results from inability or failure of our body to produce insulin, which increase Blood glucose levels rapidly and whereas in type II diabetes mellitus the person requires to inject the insulin or wear an insulin pump has emerged as a pandemic health problem in the world right now, and the prevalence is increasing rapidly and the type II diabetes mellitus which accounts for about 20% to 50% cases of new-onset of diabetes in the young people, it is a common endocrine disorder, which is also associated with several electrolytic disorders and this also leads to the disturbances in the thyroid gland. The thyroid gland is one of the most important organs in the human body. It regulates the majority of the body's physiological actions. Thyroid hormone has an impact on renal tubular function and the renin-angiotensin system and is associated with hemodynamic and cardiovascular alterations that interfere with renal blood flow. Conversely, the kidney is not only an organ for the metabolism and elimination of TH but also a target organ of some of the actions of the iodothyronines. The thyroid hormone is a central regulator of body functions, disorder of thyroid functions is considered to cause electrolytic disorders in diabetes mellitus patients. The present cross-sectional study investigated whether thyroid parameter concentrations, including thyroid-stimulating hormone (TSH), free triiodothyronine (FT3), free thyroxine (FT4), T3, T4, thyroid peroxidase antibody (TPOAb), and thyroglobulin antibody (TgAb). it had been correlated with electrolytes levels in Diabetic patients. The aim of the study is to study the serum electrolytes levels and thyroid dysfunction in the DM patients. It is a retrospective – cross sectional study. Sample size - 100 (50- DM patients and 50 -Non Diabetic age matched controls). Medical records of and laboratory reports of 50 patients and 50 controls were retrieved and parameters were retrospectively viewed for clinical findings. The results had showed a significant difference among the controls and the patients. It may be concluded from this study that dysregulation of glucose homeostasis may leads to renal failure, renal stones, cardiac arrhythmias due to increase in sodium & potassium levels, and it also can cause hypogonadism, in future the further studies are needed in order to study the underlying mechanism of electrolytes in diabetes mellitus.

Keywords: Fasting Blood Sugar (FBS), Diabetes Mellitus (DM), Hypokalemia, Hyperkalemia, Hypothyroidism, Hyperthyroidism.

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INTRODUCTION

Diabetes is a group of metabolic diseases and it is of increasing concern in which a persons will have a high blood glucose level, because the body does not produce enough insulin or because the cells in the body does not respond to the insulin that is produced, majorly diabetes have been classified into three types. Type I diabetes mellitus results from the body failure to produce insulin, which increase rapidly and whereas in type II, In DM it requires the person to inject insulin or wear an insulin pump has emerged as a pandemic health

problem in the world, and the prevalence is increasing rapidly and the type II diabetes mellitus which accounts for about 20% to 50% cases of new-onset of diabetes in our young people.¹ It is a common endocrine disorder, which is also associated with several electrolytic and thyroid disorders. The association of thyroid dysfunction with type II DM is widely known and this study was first published in 1979.² The thyroid hormones directly controls insulin secretion. In hypothyroidism there is a reduction in glucose-induced insulin secretion by beta cells and catecholamines are increased in hyperthyroidism, and insulin resistance will be increased³⁻⁵. The DM influences the thyroid dysfunction in two sites, first at the level of hypothalamus by controlling TSH release and second at the peripheral tissues by converting T4 to T3⁶.

It was reported that type 2 DM patients with subclinical hypothyroidism are at risk of complications like neuropathy and cardiovascular events⁷. Studies suggested



that detection of subclinical hypothyroidism especially in type II DM is required to avoid further complications.

Potassium

In type I diabetes mellitus Insulin deficiency is more common than in type II diabetes mellitus. The insulin mediated glucose intake is impaired, but the potassium intake of cells remains normal. Hyperkalemia occurs due to increase in plasma tonicity that results from the redistribution of potassium intercellular space to extracellular space, in patients with type 2 diabetes the insulin mediated uptake of glucose will be impaired, but in the cell potassium uptake will be normal in a situation that is consistent with divergence of intracellular pathways that follows the activation of insulin receptor.² The hyperkalemia can also be caused due to an increase in the tonicity of the plasma which was caused by the redistribution of potassium from the intracellular space to the extracellular space.³ The potassium efflux from the cells is due to intracellular dehydration and osmotically induced transcellular movement of water, this will create a favorable gradient for the efflux of potassium.⁴ In addition to that potassium shifts that are the result of hypertonicity and insulin deficiency are counterbalanced by marked increases in the sympathetic nerve activity, this increased activity moves potassium into the cells by stimulating β_2 -adrenergic receptors⁵. In patients receiving non selective beta blockers, increased adrenergic activity may worsen hyperkalemia because unopposed stimulation of α -adrenergic receptors favors the cellular efflux of potassium⁶.

Sodium

Diabetes mellitus is a well known cause of dysnatremias via several underlying mechanisms⁷⁻⁹ glucose is one of the osmotically active substance, whenever hyperglycemia occurs this will increase osmolality of the serum, which resulting in movement of water out of the cells and subsequently in a reduction of serum sodium levels (Na) by dilution. Therefore in hyperglycemic patients the sodium levels should be taken into account which is calculated by adding to measured (Na+)1.6 mmol/L for every 100 mg/dL (5.55 mmol/L) increment of serum glucose above normal a correction factor by 2.4 mmol/L is used when serum glucose concentration are higher than 400 mg/dL (22.2 mmol/L)¹⁰⁻¹¹, uncontrolled DM also induce hypovolemic hyponatremia due to osmotic diuresis, moreover in diabetes ketoacidosis, ketone bodies (beta-hydroxy butyrate and acetoacetate) obligate urinary electrolyte losses and aggravate the renal sodium wasting.¹²⁻¹³ The loss of water in excess sodium and potassium due to osmotic diuresis can lead to hypernatremia if this water loss is replaced insufficiently.

Magnesium

Hypomagnesemia is a common electrolyte disorder in diabetic patients.¹⁴ Recent studies shows that diabetes mellitus was identified as an independent risk factor for the hypomagnesemia patients aged 55 years and osmotic

diuresis accompanied by in appropriate mangnesiuria was the prominent underlying mechanism of hypomagnesemia in these diabetic patients¹⁵, increased gastrointestinal Mg^{2+} losses due to diarrhea as a result of diabetic autonomic neuropathy which also leads to hypomagnesemia. In a case of symptomatic hypomagnesemia [serum Mg^{2+} concentration 0.66 mEq/L (0.33 mmol/L), reference range 1.42-1.84 mEq/L (0.71-0.94 mmol/L)] was attributed to metformin-induced diarrhea¹⁶ insulin also promotes the net shift of Mg^{2+} from extracellular to intracellular space and can also contribute to hypomagnesemia.¹⁷⁻¹⁸ Some of the studies also suggest that hypomagnesemia is a predictor for the end stage renal diseases in patients with diabetic nephropathy.¹⁹ Apart from these magnesium deficiency is also associated with carbohydrates intolerance and insulin resistance, thus it worsening the diabetes mellitus which already exists moreover the increased dietary Mg^{2+} intake will reduce the risk for type II DM.

There are contradictory reports regarding the prevalence of electrolyte disturbances and thyroid dysfunction among normal and patients with type II DM²⁰⁻²². Hence the study was designed to assess the serum electrolytes in type II DM.

Aim and Objective

Study the serum electrolytes level and thyroid dysfunction in the DM patients.

MATERIALS AND METHODS

- It is a retrospective – cross sectional study.
- Sample size - 100 (50- Diabetes mellitus patients and 50 - Non Diabetic) age matched controls.
- Medical records of and laboratory reports of 50 patients and 50 controls were retrieved and these things were retrospectively viewed for clinical findings.

Inclusion Criteria

- Patients with diabetes mellitus were included.

Exclusion Criteria

- The subjects with other metabolic syndrome (Were excluded).

Collection of Blood Samples

- 10 ml of blood samples were collected into a labeled heparinized bottle.
- Centrifuged and plasma was separated.
- Blood samples were used for the analysis.

Anthropometric Clinical and Biochemical Measurements

- Age
- BMI
- Sex were noted



- Estimation of Blood glucose was done by using (GOD-POD method) using semi-auto analyzer.²³
- Serum electrolytes were calculated by using FLEA method (Semi auto analyzer).
- Estimation of thyroid hormones (T3, T4 & TSH) by using (CLIA -method) chemiluminescence immune assay method.¹²

RESULTS

Table 1: The anthropometric and biochemical measurements

Parameters	Diabetes (50)	Controls (50)	P* Value
HbA1C	8.8±1.9	4.5± 0.4	<0.05
FBS	186± 12	108±13	<0.05
Sodium	242.6±28.5	138±13.3	<0.05
Potassium	5.40±0.65	4.16±0.82	<0.05
Chloride	116±5.5	99.7±0.04	>0.05
T3	1.27±0.62 nmol/L	1.62±0.54 nmol/L	<0.05
T4	82.14±16.29 nmol/L	85.9±14.09 nmol/L	>0.05
TSH	4.10±3.27 nmol/L	2.48± 1.66 nmol/L	<0.05
Plasma Glucose (FPS)	170 ± 10 mg/dl	93 ±13 mg/dl	<0.05

P * value < 0.05 then it is considered to be statistically significant

Table 1 shows the anthropometric and clinical measurements of diabetic and non-diabetic subjects which includes FPS level in type II diabetes mellitus patient was found to be (186± 12) mg/dl which is significantly higher than the control subjects (108±13) mg/dl. The T3 and T4 levels (1.27±0.62 nmol/L) and (82.14±16.29 nmol/L) were significantly lowered in type II diabetes mellitus patients when compared to the non-diabetic healthy age matched controls (1.62±0.54 nmol/L) and (85.9±14.09 nmol/L). Meanwhile the serum TSH was significantly increased in type II diabetes mellitus subjects (4.10±3.27 nmol/L) as compared to the non-diabetic healthy age matched controls (2.48 ±1.66 nmol/L).

Table 2: The Correlation of FBS with the Electrolytes

Electrolytes	r * value	P * value
Sodium (Na ⁺)	-0.233	0.017
Potassium (K ⁺)	0.016	>0.05
Chloride (Cl ⁻)	0.21	0.04

P* value < 0.05 then it is considered to be statistically significant

In this study total of 100 subjects were included in which 50 were diabetic and 50 were age matched healthy controls.

Table 1 shows the anthropometric biochemical measurements which includes Age, HbA1c, FBS, Sodium, potassium and chloride and thyroid hormone levels in both diabetic and control groups in which HbA1c was comparatively increased in the diabetic patients compared with non diabetic healthy controls, in diabetic patients

sodium level was found to be high when compared with controls and its statistically significant, potassium and chloride was found to be high when compared with controls in which potassium was found to be statistically significant, and chloride was found to be non-significant.

Table 2 shows the correlation FBS with the electrolytes in which sodium was negatively correlated P* and r * value was found to be (P* 0.017 and r * -0.233) which is statistically significant. FBS was correlated positively with potassium the P* and r * value was found to be (P* >0.05 and r * 0.016) and it shows non significance. FBS was correlated positively with chloride and P* and r * value was found to be (P*0.04 and r *0.21) it was also found to be statistically significant

DISCUSSION

Our study includes 50 type II diabetes mellitus patients and 50 non diabetic age matched healthy controls. One of the primary problems with DM is that the amount of glucose in the blood will damage the proportion of serum electrolytes in the body. The association between blood glucose and serum electrolytes is a multipart in which it is related to a number of other factors. which includes age and associated conditions. Serum electrolyte imbalance in type 1 diabetes which is primarily a result of elevated blood glucose, the body tries to rid itself the excess blood glucose by increasing urinary output. Increased urination leads to loss of electrolytes and water and results in the imbalance which especially disturbs sodium and potassium levels in the body.

The thyroid hormone act as an insulin antagonist which potentiate the insulin action indirectly. In diabetes mellitus the TRH synthesis decreases and this is responsible for the occurrence of low thyroid hormone levels in diabetes. In our study, the TSH level was found to be clinically significant



in type II diabetes mellitus patients compared to non diabetic age matched controls.

According to the results obtained in our study, that type II diabetes mellitus patients were more prone to hypothyroidism frequently and the results of our present study was compared in accordance with the report of Gujarat singh et al¹², Suzuki et al¹³, demitrost et al¹⁴ valeri witting et al¹⁵ they all are the person who have shown a separate study on thyroid profile in diabetic patients, our study shows a significant correlation with the thyroid hormone and the blood glucose levels in the type II diabetes mellitus patients Uncontrolled DM can also induce hypovolemic-hyponatremia due to osmotic diuresis furthermore in diabetic ketoacidosis, ketone bodies (beta-hydroxy butyrate and acetoacetate) necessitate urinary electrolyte losses and magnify the renal sodium wasting. In a study 113 hypernatremic in one third of cases (34.5%)²⁴. accordingly in patients with uncontrolled diabetes mellitus the serum sodium level varies and it reflects on the balance between the hyperglycemia induced water movement out of the cells that lowers sodium and glucosuria induced osmotic diuresis,²⁵ which increases the sodium levels in the body. In our study we found that sodium levels in diabetes patients was found to be high when compared with controls and sodium was correlated negatively with glucose and it was found to be statistically significant.

Several studies have shown that hypokalemia was found to be a particular concern in DM due to some of the major causes such as a) redistribution of potassium [K⁺] from the extracellular to the intracellular fluid compartment (shift hypokalemia due to insulin administration), b) gastrointestinal loss of K⁺ due to malabsorption syndromes, c) renal loss of K⁺ (due to osmotic diuresis and/or coexistent hypomagnesemia).²⁶⁻²⁷

Our study shows that the DM patients were more prone to mild hyperkalemia, when compared to the healthy controls. Some of the studies have shown that the exogenous insulin can induce mild hypokalemia because it promotes the potassium influx into the skeletal muscles and hepatic cells which increases the activity of Na⁺ and K⁺ ATP ase pump. and hypokalemia is also associated with impaired insulin secretion and decreased peripheral glucose utilization which results in carbohydrate intolerance and hyperglycemia²⁸⁻³⁰.

Elevated serum Cl⁻ levels were found in diabetes patients and this might be due to diabetic ketoacidosis. Ketoacidosis cause reduction in blood pH which further disturbs acid base balance and leads to the elevation of chloride. Despite of Na⁺, Cl⁻ levels in males were found more significant and correlated positively (P<0.05) with HbA1C.

SUMMARY and CONCLUSION

To sum up 50 patients with DM and 50 healthy controls were screened it was observed that thyroid function levels were altered in DM patients, in particular with T3 and TSH levels and it may be concluded that a regular screening of diabetes mellitus patients for thyroid function studies is

recommended to avoid further complications of thyroid dysfunctions.

From the above studies it was observed that the dysregulation of glucose homeostasis may leads to many direct & indirect effects and which may likely lead to renal failure, renal stones, cardiac arrhythmias due to increase in sodium & potassium levels, and this also can lead to hypogonadism. In which patients might not be able to permeate the opposite sex, which is as result of low level of testosterone hormone, the high prevalence of diabetes and familiarity of electrolytes related abnormalities are important, in future the further studies are needed in order to study the underlying mechanism of electrolytes in DM and thyroid hormones.

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