National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

Assessment of serum lipid profile and electrolyte levels in Type II diabetes mellitus – A comparative study based on glycosylated hemoglobin levels

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Received: March 15, 2019; **Accepted:** April 20, 2019

ABSTRACT

Background: There are currently around 40.9 million patients with diabetes mellitus (DM) in India. Imbalanced lipid profiles and deranged electrolyte levels in the body are commonly seen in DM patients. Glycosylated hemoglobin (HbA_1c) refers to the glucose-derived products of normal hemoglobin (HbA). **Aims and Objectives:** The objectives of this study were as follows: (A) To assess serum electrolyte levels, serum lipid profile, fasting blood sugar (FBS), and HbA_1c levels in Type II diabetic subjects and (B) to find out the correlation of lipid profile and electrolyte levels with HbA_1c. **Materials and Methods:** This retrospective study was conducted in Yenepoya Medical College Hospital, Mangalore. In minimal residual disease, files of patients with type II DM of the age group of 25–70 years were retrieved and were grouped into Group A (44 uncontrolled Type II diabetes patients with $HbA_1c \geq 6.5\%$) and Group B (44 controlled Type II diabetic subjects with $HbA_1c < 6.5\%$). Fasting lipid profiles such as total cholesterol (TC), triglycerides, high-density lipoprotein (HDL) and low-density lipoprotein (LDL), FBS, HbA_1c, and serum electrolytes (sodium, potassium, and chloride) were collected. **Results:** There was a statistically significant decrease ($P < 0.001$) of serum sodium, potassium, and HDL levels and a statistically significant increase ($P < 0.001$) of FBS, TC, triglyceride, and LDL levels in Group A (uncontrolled Type II diabetes) compared to Group B (controlled Type II diabetes). **Conclusion:** HbA_1c can be used as an effective indicator of dyslipidemia and electrolyte imbalance, and in this way, early diagnosis of dyslipidemia and electrolyte imbalances can be used to prevent complications in Type II DM patients.

KEY WORDS: Type II Diabetes Mellitus; Glycosylated Hemoglobin; Lipid Profile; Electrolytes; Dyslipidemia

INTRODUCTION

There are currently around 40.9 million patients with diabetes mellitus (DM) in India. The high burden of diabetes may be associated with an increase in the number of complications. India is the diabetic capital of the world. By 2030, about 80–87 million people of India will be diabetic. The prevalence of DM affecting mainly urban population was estimated to be 4.4% in 2030.[1]

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2019.9.0309020042019	

Glycosylated hemoglobin (HbA_1c) refers to the glucose-derived products of normal hemoglobin (HbA). Normally, HbA_1c concentration is about 3–5% of the total HbA. During sustained hyperglycemia, as in DM, the HbA_1c concentration may be elevated to 10–20% of the total HbA. Determination of HbA_1c has become an important tool for monitoring of diabetes control and proper regulation of insulin therapy. Measuring HbA_1c levels help in predicting the risk of having complications in diabetes patients. It has been found that increased HbA_1c levels have become a risk factor for

cardiovascular disease in both diabetes and non-diabetic subjects.[2,3]

Imbalanced lipid profile as well as electrolyte levels in diabetic subjects may result in developing complications of DM. Serum electrolytes and lipids play a major role in the normal functioning of the body. Therefore, any changes in the concentrations of lipids or electrolytes provide indications of disease progression in DM.

Dyslipidemia includes the changes in the total cholesterol (TC) level, high-density lipoprotein (HDL) level, low-density lipoprotein (LDL) level, and serum triglyceride level. Since the insulin deficiency or resistance affects the key enzymes and pathways in the lipid metabolism, there could be abnormal lipid profiles in DM. In DM, apoprotein production, regulation of lipoprotein lipase, action of cholesteryl ester, and hepatic as well as peripheral actions of insulin are all affected.[4-7]

Electrolyte disorders are frequently seen in decompensated diabetics. Electrolytes play a major role in controlling the body fluid levels, maintaining the acid-base balance (pH), helps in nerve conduction, promotes blood clotting, and helps in muscle contraction. For a proper electrolyte balance, the levels of sodium, potassium, and chloride should be maintained. Electrolyte imbalance is now predominantly seen in diabetic patients as a result of an irregular distribution of electrolytes or it's relation to hyperglycemia-induced osmotic fluid shifts. A dilutional effect on electrolyte concentrations is formed; as a result, hyperglycemia sets the internal environment for osmotic diuresis. Glucose which has an osmotic effect can result in lowering the levels of circulating blood volume and thereby ultimately leading to cellular dehydration.[8-10]

MATERIALS AND METHODS

The present retrospective study was conducted in Yenepoya Medical College Hospital (YMCH), Mangalore, after the approval of the Institutional Ethics Committee (Yenepoya Ethics Committee-1). After the ethical committee clearance, the files of patients with Type II DM (International Classification of Diseases code E11.9) were retrieved from minimal residual disease (MRD). These files were grouped into Group A (44 cases of uncontrolled Type II diabetes patients with HbA_1c ≥6.5%) and Group B (44 cases of controlled Type II diabetic subjects with HbA_1c <6.5%). Files were retrieved of patients of both genders admitted to YMCH, Mangalore, from March 2018 to February 2019 of the age group of 25–70 years.

The following data were collected from MRD files:

a) Fasting lipid profile (TC, triglycerides [TGs], HDL, and LDL)
b) Fasting blood sugar (FBS)
c) HbA_1c level
d) Serum sodium, potassium, and chloride levels.

During collection of data, no private information or no sensitive information of the patients were collected. All the data were kept confidential.

Inclusion Criteria

Type II DM patients of the age group of 25–70 years of both genders admitted in YMCH, Mangalore were included in the study.

Exclusion Criteria

The following criteria were excluded from the study:

i. Type I DM
ii. Pregnancy
iii. Patients with thyroid dysfunction
iv. Chronic kidney diseases.

Statistical analysis was performed using SPSS software with Student's t-test, and Pearson's correlation was used to compare HbA_1c with FBS, lipid profile, and electrolytes.

RESULTS

Observations of the present study are recorded in Tables 1 and 2.

There was a statistically highly significant decrease ($P < 0.001$) of serum sodium, potassium, and HDL levels and a statistically highly significant increase ($P < 0.001$) of FBS, TC, triglyceride, LDL, and serum chloride levels in

Table 1: Comparison of biochemical parameters and serum electrolytes in Type II DM

Parameters	Group A (Mean±SD)	Group B (Mean±SD)	*P* value
Age (years)	50.82±10.65	50.39±12.19	0.860
HbA_1c (%)	9.93±2.63	5.44±0.59	0.000**
FBS (mg/dl)	191.30±89.95	97.95±13.98	0.000**
TC (mg/dl)	191.86±49.02	152.91±30.38	0.000**
TG (mg/dl)	219.77±109.69	111.07±32.08	0.000**
HDL (mg/dl)	25.57±8.30	42.09±12.25	0.000**
LDL (mg/dl)	118.18±37.37	90.84±24.86	0.000**
Sodium (mmol/L)	133.18±3.97	138.02±4.96	0.000**
Potassium (mmol/L)	3.36±0.53	4.08±0.46	0.000**
Chloride (mmol/L)	104.68±3.05	101.21±4.85	0.000**

Each value is expressed as mean±SD for each group. ** Statistically highly significant. SD: Standard deviation, TC: Total cholesterol, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, TG: Triglyceride, FBS: Fasting blood sugar, HbA_1c: Glycosylated hemoglobin, DM: Diabetes mellitus

Table 2: Correlations of HbA_1c with FBS, lipid profile, and serum electrolytes in Type II DM

Parameters	FBS	TC	TG	HDL	LDL	Sodium	Potassium	Chloride
HbA_1c	r=0.805** *P*=0.000	r=0.355** *P*=0.001	r=0.452** *P*=0.000	r=−0.423** *P*=0.000	r=0.340** *P*=0.001	r=−0.386** *P*=0.000	r=−0.438** *P*=0.000	r=0.267* *P*=0.012

r-correlation coefficient, Correlation is significant at the 0.01 level**, Correlation is significant at the 0.05 level*, TC: Total cholesterol, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, TG: Triglyceride, FBS: Fasting blood sugar, HbA_1c: Glycosylated hemoglobin, DM: Diabetes mellitus

uncontrolled Type II diabetic subjects (Group A) compared to controlled type II diabetic subjects (Group B).

This study also showed a positive correlation of HbA_1c with FBS, TC, TG, LDL, and serum chloride levels. However, HbA_1c was negatively correlated with serum sodium, potassium, and HDL levels [Table 2].

DISCUSSION

In our study, there was a statistically highly significant decrease ($P < 0.001$) of serum sodium, potassium, and HDL levels and a statistically highly significant increase ($P < 0.001$) of FBS, TC, TG, LDL, and serum chloride levels in uncontrolled Type II diabetic subjects (Group A) compared to controlled type II diabetic subjects (Group B). Our study also showed a positive correlation of HbA_1c with FBS, TC, TG, LDL, and serum chloride levels. However, HbA_1c was negatively correlated with serum sodium, potassium, and HDL levels.

The present results showed a statistically significant increase ($P < 0.001$) in the serum level of TG, TC, and LDL cholesterol and a statistically significant decrease ($P < 0.001$) in HDL cholesterol in uncontrolled type II diabetics relative to controlled type II diabetic subjects. The result is consistent with the studies conducted Lamarche *et al*. Goldberg in his study explained that the cause of dyslipidemia in Type II DM might be due to the improper working of insulin affecting the production of apolipoprotein in the liver. Goldberg also explained that hyperglycemia can increase the transfer of cholesterol esters from HDL to very LDL particles. The insulin deficiency in Type II DM results in lower HDL levels and higher TG levels, which can be improved by good glycemic control.[4,11]

In the present study, we have evaluated the correlation of lipid profile parameters in diabetic subjects with HbA_1c. Group A subjects with $HbA_1c \geq 6.5\%$ exhibited a significant increase in FBS, TC, TG, and LDL compared to Group B subjects [Table 1]. Our study also showed a highly significant correlation between HbA_1c and FBS, TC, TG, LDL, and HDL. The findings were consistent with the studies of Wexler *et al*. and Selvin *et al*.[12,13]

The present study showed a very high significant reduction in serum sodium and potassium levels and an elevation in serum chloride level in subjects with uncontrolled Type II DM. As a result of insulin deficiency, hyperglycemia, and hyperketonemia, there may be derangement of water and electrolyte balances in DM subjects. The result was consistent with the studies of Kitabchi *et al*., Wang *et al*., and Haglin *et al*. Initially, water moves from the intracellular compartment to the extracellular compartment because hyperglycemia is known to be restricted in the extracellular space, thus diluting the plasma sodium level. During the accompanying osmotic diuresis, the loss of water will be similar to both the compartments (intracellular and extracellular), as there was excess loss of water more than sodium. Therefore, the concentration of plasma sodium may be lowered in uncontrolled Type II DM. Glucose is an effective osmole during poorly controlled DM, and therefore, water is drawn from the muscle cells resulting in hyponatremia.[14-17]

The detected decline in the serum sodium and potassium in the present study group may be due to electrolyte loss. This electrolyte loss may occur due to the abnormal function of kidney, diabetic nephropathy, or dehydration. This kind of electrolyte imbalance can be seen due to inhibition of the renin-angiotensin-aldosterone system, which plays a major role in the regulation of the electrolyte and fluid balance. Elevated serum chloride levels were found in uncontrolled Type II diabetes patients and this might be due to diabetic ketoacidosis. Ketoacidosis causes reduction in the pH of blood which further leads to the elevation of chloride. The result of our study was consistent with the study of Cowie and Harris.[18]

Strength and Limitations of Study

The differences found in the lipid profile and serum electrolyte levels in Type II DM subjects can be used as a diagnostic tool in our daily practice. HbA_1c can be used as an effective indicator of dyslipidemia and electrolyte imbalance, and in this way, early diagnosis of dyslipidemia and electrolyte imbalances can be used to prevent complications in Type II DM patients.

This study has several limitations. As it was a retrospective study, the history of the patient was not taken. Medication uses such as beta-blockers and diuretics which can alter the lipid profile and electrolyte levels were not considered in this study.

CONCLUSION

The increase in TC, TG, LDL, and decline in HDL with HbA_1c rise shows that the impact of glycemic control on lipoprotein levels and that hyperlipidemia of diabetic patients may be correctable by improving blood sugar. Electrolyte abnormalities are now predominantly common in diabetes patients. Our study concluded that the differences found in the lipid profile and serum electrolyte levels in Type II DM subjects can be used as a diagnostic tool in our daily practice. HbA_1c can be used as an effective indicator of dyslipidemia and electrolyte imbalance, and in this way, early diagnosis of dyslipidemia and electrolyte imbalances can be used to prevent complications in Type II DM patients.

ACKNOWLEDGMENT

I immensely thankful to Dr. Aswini Dutt R, Professor and HOD, Department of Physiology; Mr. Hashim A, Department of Forensic Medicine; and Mr. Anwar A S for helping me to carry out this study**.**

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How to cite this article: Rahiman NBA, Bangera S, Hameed SS. Assessment of serum lipid profile and electrolyte levels in Type II diabetes mellitus – A comparative study based on glycosylated hemoglobin levels. Natl J Physiol Pharm Pharmacol 2019;9(7):617-620.

Source of Support: Nil, **Conflict of Interest:** None declared.