Section: Biochemistry

Original Research Article

A STUDY TO CORRELATE HbA1C, LIPID PROFILE & MAGNESIUM WITH HYPERTENSION IN TYPE 2 DIABETES MELLITUS ATTENDING AT RAMA MEDICAL COLLEGE HOSPITAL & RESEARCH CENTER

Rahul Kumar[1], Pawan Arun Kulkarni[2], Shrawan Kumar[3], Pavan Kumar Sharma[4], Mahesh Shrivastav[5]

[1]PG scholar, Department of Biochemistry, Rama Medical College Hospital and Research Centre, Kanpur U.P. India.
[2]Professor and HOD, Department of Biochemistry, Rama Medical College Hospital and Research Centre, Kanpur, U.P. India.
[3]Professor and HOD, Department of Medicine, Rama Medical College Hospital and Research Centre, Kanpur, U.P. India.
[4]Associate Professor, Department of Biochemistry, Rama Medical College Hospital and Research Centre, Kanpur, U.P. India
[5]Tutor, Department of Biochemistry, Rama Medical College Hospital and Research Centre, Kanpur, U.P. India

Received : 05/04/2023
Received in revised form : 25/04/2023
Accepted : 03/05/2023

Keywords:
Hypertension, type2 diabetes mellitus, lipid profile, magnesium &HbA1c.

Corresponding Author:
Dr. Shrawan Kumar,
Email: drshrawanknp@gmail.com

DOI: 10.47009/jamp.2023.5.5.5

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

Int J Acad Med Pharm
2023; 5(5); 22-28

Abstract

Background: One of the most prevalent metabolic disorders and a major global cause of death and disability is diabetes mellitus. Deficits in both extracellular and intracellular magnesium are typically found in type 2 diabetes. The objective of our study was to investigate and link the effects of magnesium, lipid profile, and HbA1c on hypertension in patients with type 2 diabetes mellitus at Rama Medical College. **Materials and Methods:** A total of 100 participants have been identified, of which 50 will be recruited as healthy controls and 50 will be type-2 diabetes patients from the OPD of the Rama Medical College Hospital. **Result:** The present study, which indicated increased TC, TG, VLDL-C, AND LDL-C values in diabetic patients except HDL-C, it was discovered that 70% of diabetic patients had dyslipidaemia in hypertension in diabetes patients compared to hypertension in non-diabetes patients. **Conclusion:** Significant correlation between magnesium and various circulating lipid parameters.

INTRODUCTION

Diabetes mellitus is one of the most common metabolic disorder and leading cause of death and disability in the world. The incidence of diabetes is increasing globally and in India as well. W.H.O has declared India as the global capital of diabetes. In 1997 WHO estimate of the prevalence of the diabetes in adults showed an expected rise of >120% from 135 million in 1995 to 300 million in 2025. It has been estimated that 57.2 millions of Indians will be affected by diabetes by the year 2025.[1] Magnesium is second most abundant intracellular cation and fourth most abundant cation in the human body that serves as a co-factor for all enzymatic reactions that require ATP. It is an essential enzyme activator for neuromuscular excitability and cell permeability, a regulator of ion channels and mitochondrial function, a critical element in cellular proliferation and apoptosis, and an important factor in both cellular and humoral immune reactions.[2] Its involvement in cardiac excitability, gating of calcium ion channels, transmembrane ion flux and neurotransmitter release is evident.[3] Cellular magnesium is a crucial cofactor for various enzymes involved in glucose transport, glucose oxidation, insulin release, and is a cofactor for ATPase and adenylate cyclase enzymes.[4] It plays the role of a second messenger for insulin action; on the other hand, insulin itself is an important regulatory factor of intracellular magnesium accumulation.[5] Intracellular Mg plays a key role in regulating insulin action, insulin-mediated-glucose-uptake and vascular tone. Reduced intracellular Mg concentrations result in a defective tyrosine kinase activity, prosecutorial impairment in insulin action and worsening of insulin resistance in diabetic patients. A low Mg intake and an increased Mg urinary loss appear the most important mechanisms that may favor Mg depletion in patients with type 2 diabetes.[6] Type 2 diabetes is frequently associated with both

ISSN(O): 2687-5365; ISSN(P): 2753-6556

extracellular and intracellular magnesium deficits. A chronic latent Mg deficit or an overt clinical hypomagnesemia is common in patients with type 2 diabetes, especially in those with poorly controlled glycemic profiles.[7] Glycosylated Haemoglobin (HbA1 c) results from post translational changes in the haemoglobin molecule, and their levels correlate well with glycemic levels over the previous six to ten weeks. Glycosylation of haemoglobin takes place under physiological conditions by a reaction between glucose and N-terminal valine of Beta chain of Hb molecules.[8] The American Diabetes Association (ADA), European Association for the Study of Diabetes (EASD) and the International Diabetes Association (IDF) recommend the use of HbA1c assay in the diagnosis of T1DM and T2DM.[9] Measurement of glycosylated haemoglobin shows a promising approach to monitor diabetic patient and also provides a conceptual frame work for the pathogenesis of secondary sequelae of DM.[10]Studies give the evidence for high prevalence of hypertension in diabetics comparing to the nondiabetics. Also, development of type-2 diabetes is more common in hypertensive patients.[11] Good glycemic control is most important in management of diabetes mellitus. Glycated hemoglobin (HbA1c) is a routine test to monitor their glycemic control. The goal is to achieve a level below 7%. 1% increase in HbA1c estimated an increase of diabetic complications by 18%.[12] The diabetic patients on glycemic control is varied from one population to another. The correlation of HbA1c, lipid profile & magnesium is conflicting and further studies are needed to overcome this discrepancy. Also, the correlation between TG/HDL and insulin resistance is already explored, but with glycemic control is limited. The aim of the study was to analyze glycemic control, lipid profile, magnesium, BP and the correlation of these parameters. Our aim was to study and correlate HbA1c, lipid profile and magnesium with hypertension in type 2 diabetes mellitus patient at rama medical college.

MATERIALS AND METHODS

Study Settings: This study will be conducted in department of Biochemistry in association with Department of Medicine, Rama Medical College Hospital & Research Centre, Mandhana Kanpur. Sample from both outpatients and inpatients will be collected from Rama Medical College Hospital & Research Centre.

Study Subjects: A total of 100 subjects are recruited out of which 50 patients with diabetes mellitus type-2 from OPD of Rama medical college hospital and 50 age and sex matched healthy controls will be recruited in the study.

Study Design: Case control study

Study Period: This study will be conducted from April 2022 to March 2023.

Ethical Clearance: Ethical clearance will be taken from ethical committee of Rama Medical College Hospital andResearch Centre.

Specimen Collection & Storage: 5ml of fasting venous blood sample will be collected with dry disposable syringe. 3 ml in a plain vial for lipid profile and 2ml in EDTA containing vial for HbA1c estimation and under all aseptic conditions after explaining the procedure to the study subjects.Serum will be separated by allowing to clot at room temperature for 15 minutes the centrifugation at 3500 rpm (rotation per minute) for 15 minutes in the Biochemistry department and following analysis will be conducted. The serum will be stored at -20°C until analysis.

Inclusion Criteria

- Subjects between 31-60 years age group will be considered.
- Those subjects who have been diagnosed to have diabetes mellitus will be included in study group. i.e patients with fasting plasma glucose (FPG) >126 mg/dl and plasma glucose (2 hours-PG) > 200 mg/dl
- Normal healthy persons are taken as controls.
- Patient with h/o of Hypertension.

Exclusion Criteria

- Age group (<31 years or >60)□Pregnant & Lactating mothers.
- Smoking and alcoholic individuals.
- Patients with coronary heart disease.
- Patients with thyroid Disorders
- Patients with chronic renal failure
- Patients with pancreatitis
- Patients with hepatic diseases
- Patients with history of using drugs that significantly affect lipid metabolism.

Study Tool: A pretested questionnaire-based semi constructed proforma will be used as a study tool to collect the data including basic profile of participants i.e age, sex, blood pressure and intake of diabetes drugs.

Consent: A verbal or written consent will be obtained from the participants before the sample collection.

Parameters to be Measure: In the present study fallowing parameters will be measured:

a) Systolic Blood Pressure (SBP)
b) Diastolic Blood Pressure (DBP)
c) Glycosylated haemoglobin (HbA1C)
d) Total Cholesterol (TC) Triglycerides (TG)
e) High Density Lipoprotein-Cholesterol (HDL-C)
f) Low Density Lipoprotein -Cholesterol, (LDL-C)
g) Very Low-density Lipoprotein- Cholesterol (VLDL-C)

The blood sample was allowed to clot at room temperature for 30 min and sera was obtained after centrifugation at 3500 rpm (rotation per minute) for 5 minutes in the biochemistry laboratory and stored at -200 C until assayed.

ISSN(O): 2687-5365; ISSN(P): 2753-6556

RESULTS

The present study entitled as "A study to correlate HbA1c & Lipid profile & Magnesium with hypertension in type 2 Diabetes Mellitus patient attending at Rama Medical college hospital & Research Centre Kanpur" has been conducted in department of Biochemistry in collaboration with the OPD of General Medicine of Rama Medical College and Research Centre Kanpur. In the present study total 100 subjects age between 30-75 years were enrolled as study subject, out of which fifty hypertension with non-diabetic subject and fifty hypertension with type-2 diabetes subject diagnosed of diabetic disease were taken as cases. All the subjects were subjected to detailed history-taking as proforma. Test parameters were tabulated as per the master chart. The results were expressed in terms of mean±SD. The p value <0.05 was considered as significant.

Group I = Hypertension with type-2 diabetes patients

Group II =Hypertension with non-diabetes patients.

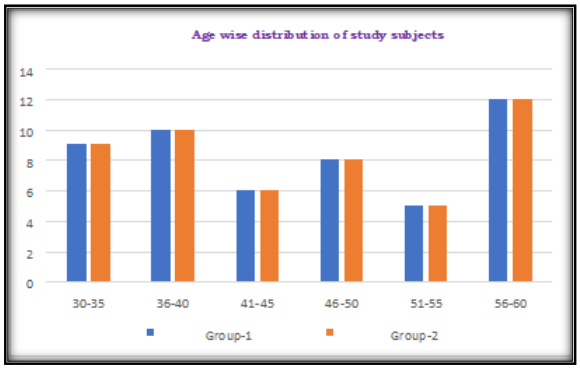

Figure 1: Showing age wise distribution of study subjects.

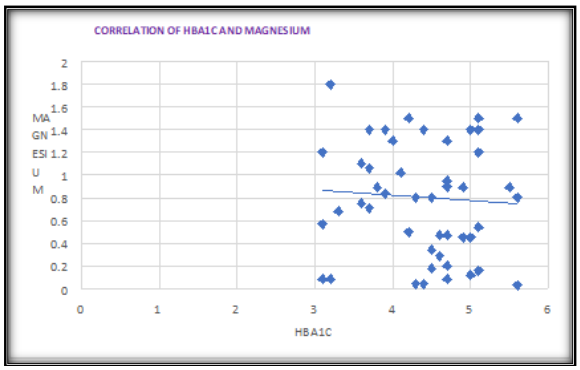

Figure 2.1: Show the scatter plotting indicates negative correlation between HbA1c and Magnesium in group I.

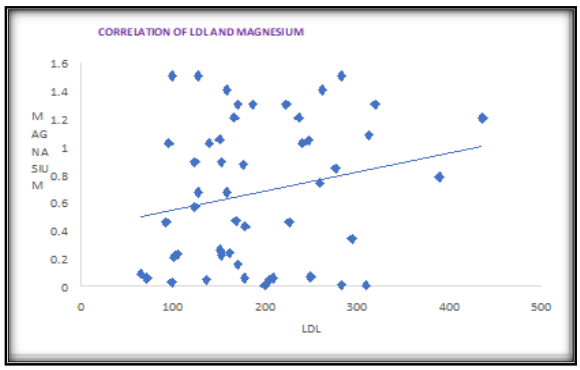

Figure 2.2: Show the scatter plotting indicates positive correlation between LDL and magnesium in group I.

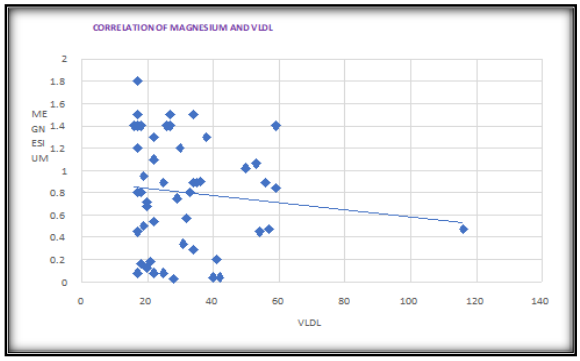

Figure 2.3: Show the scatter plotting indicates negative correlation between magnesium and VLDL group I.

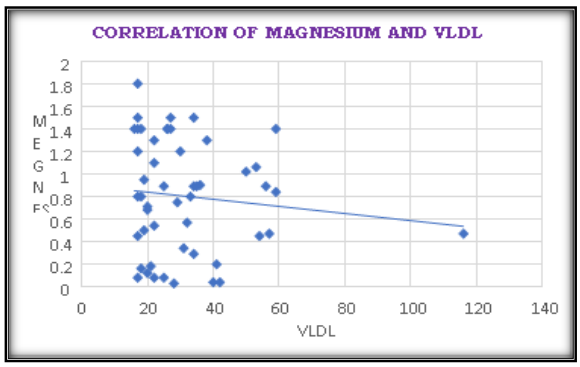

Figure 2.4: Show the scatter plotting indicates negative correlation between HDL and magnesium in group I.

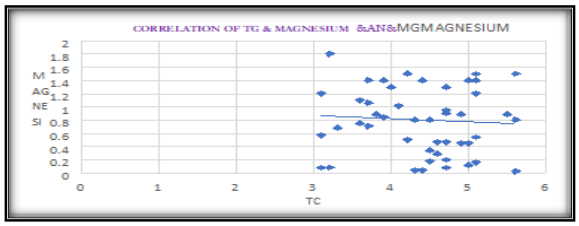

Figure 2.5: Show the scatter plotting indicates negative correlation between TG and Magnesium in group I.

ISSN(O): 2687-5365; ISSN(P): 2753-6556

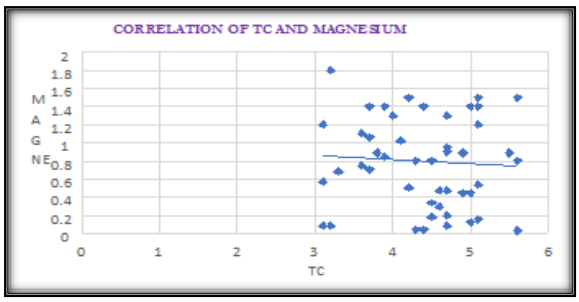

Figure 2.6: Show the scatter plotting indicates negative correlation between TC and Magnesium in group I.

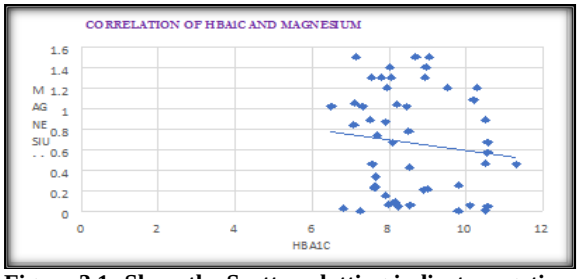

Figure 3.1: Show the Scatter plotting indicate negative correlation between HbA1c and magnesium in group II.

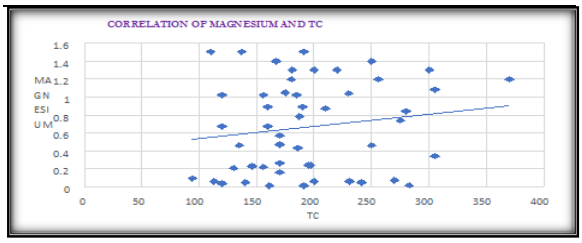

Figure 3.2: Show the Scatter plotting indicate positive correlation between magnesium and TC in group II.

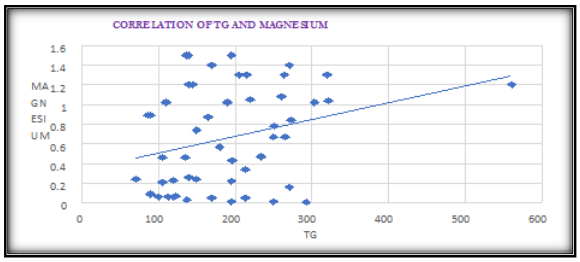

Figure 3.3: Show the Scatter plotting indicate positive correlation between TG and magnesium in group II.

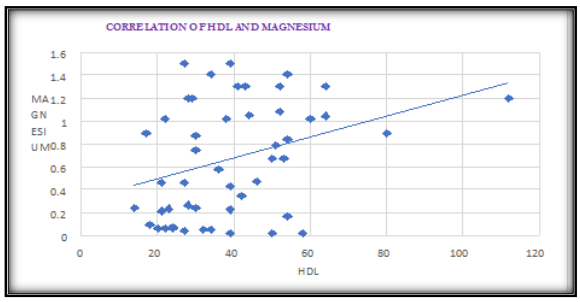

Figure 3.4: Show the Scatter plotting indicate positive correlation between HDL and magnesium in graph II.

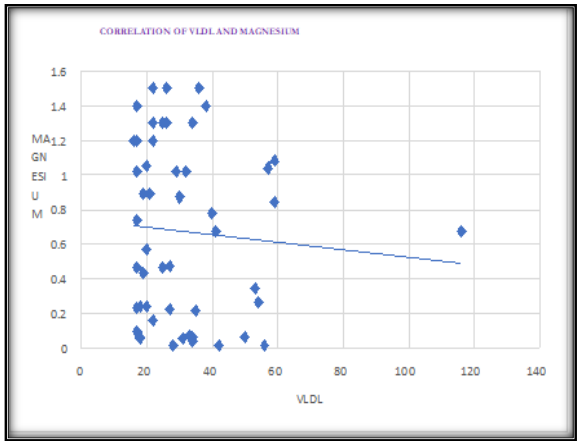

Figure 3.5: Show the Scatter plotting indicate negative correlation between VLDL and magnesium in graph II.

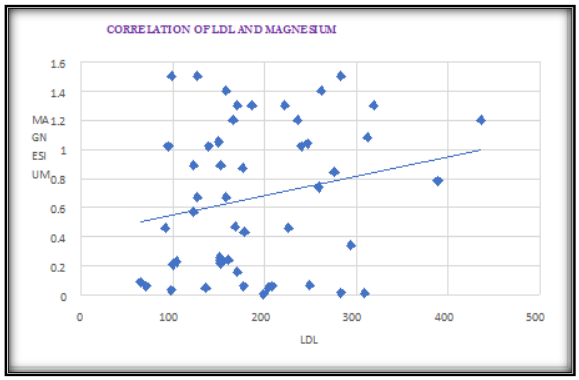

Figure 3.6: Show the Scatter plotting indicate positive correlation between LDL and magnesium in group II.

Table 1: Shows the comparison of serum HbA1C, Lipid profile and magnesium in diabetic and non-diabetic subject.

Parameter	Group-1(Mean ±SD)	Group-II(Mean ±SD)	P-value
Total cholesterol (mg/dl)	194.78±60.07	202.76±70.99	0.29
Triglyceride(mg/dl)	192.26±86.1	158.32±87.79	0.03
LDL-c (mg/dl)	191.54±80.96	182.8±80.25	0.31
HDL-c (mg/dl)	50.66±8.16	49.86±7.85	0.44
VLDL-c (mg/dl)	39.26±1.79	31.46±17.62	0.01
Magnesium(mg/dl)	0.66±0.50	0.80±0.49	0.06
HbA1c (%)	8.56±1.20	4.41±0.70	<.0001

DISCUSSION

The present study was conducted among men and women in the age group of 30-60 years diagnosed case with Hypertension in type 2 diabetic mellitus and Hypertension in non-diabetic patients attending the OPD of medicine department at Rama medical college Hospital and Research center, Mandhana, Kanpur. A total of 50 cases and 50 controls were included in this study.

Comparison of serum HbA1C between hypertension in diabetic patients and hypertension in non-diabetic patients.

ISSN(O): 2687-5365; ISSN(P): 2753-6556

According to [Table1] comparison of serum HbA1c between hypertension in diabetes patients and non-diabetes patients showed mean value of case & control i.e 8.5 & 4.4 respectively are significant and mean value of HbA1c in case study was reported higher where as in control study let reported as normal value. Hba1c is formed by non enzymatic glycation of hemoglobin in my study according to Table-1mean value of HbA1c of group 1 and group 2 were 8.56±1.20 and 4.41±0.70 similar finding were reported by P.Murliswaran et at.

Comparison of serum magnesium between hypertension in diabetic patients and hypertension in non-diabetic patients.

According to [Table1] comparison of serum magnesium between hypertension in diabetes patients and non-diabetes patients showed mean value of both case & control observed lower value as we compare reference range. the p value of case &control is not significance. Arpaci et al., Corica et al. found similar finding in their respective study.

Comparison of serum VLDL between hypertension in diabetic patients and hypertension in non-diabetic patients.

According to [Table1], comparison of serum VLDL between hypertension in diabetes patient & hypertension in non-diabetes patients. There mean shows that case and control both comes under the normal reference range. They both are significant $p<0.50$. This is unlike the findings of Jain HL.R et al.[13]

Comparison of triglyceride between hypertension in diabetic patients and hypertension in non-diabetic patients.

According to [Table1] comparison of serum TG between hypertension in diabetes patients and non-diabetes patients showed mean value of case & control i.e. 192.26 & 158.32 respectively are significant and mean value of TG in case study was reported higher than control study, in control study reported come normal. They both are significant $p<0.50$. siwei Chen and Wenkecheng et al. observed similar finding in their respective study.

Comparison of HDL between hypertension in diabetic patients and hypertension in nondiabetic patients.

According to [Table1] comparison of serum HDL between hypertension in diabetes patients and non-diabetes patients showed mean value of case & control i.e. 50.66 & 50.86 respectively are not significant and mean value of HDL in case & control study was reported both are come normal reference range. They both are significant $p<0.50$. Arora RI, Thakurdas B2 observed similar matched in their respective study.

Comparison of LDL between hypertension in diabetic patients and hypertension in nondiabetic patients.

According to [Table1] comparison of serum LDL between hypertension in diabetes patients and non-diabetes patients showed mean value of case & control i.e 191.54 & 182.8 respectively are not significant and mean value of LDL in case & control study was reported higher than normal reference range.This is similar the findings of Akintunde, Lepira et al. and Kesteloot et al.

Comparison of TC between hypertension in diabetic patients and hypertension in nondiabetic patients.

According to [Table1] comparison of serum TC between hypertension in diabetes patients and non-diabetes patients showed mean value of case & control i.e 194.78 & 202.76 respectively are not significant and mean value of TC in case & control study was reported both are come normal reference range. They both are significant $p<0.50$.This is unlike the findings of Akintunde, Lepira et al. and Kesteloot et al. who reported that the TC, TG, and LDL-C of newly diagnosed hypertensive patients did not differ significantly from that of control subjects, though the newly diagnosed hypertensive tended to have a higher level of LDL-C, TG, TC. In my present study observed that the correlation between HbA1c and magnesium, VLDL and magnesium, HDL and magnesium, TG and magnesium, TC and magnesium was negative only LDL and magnesium was positive in group-1.Mario Barbagallo* and Ligia J. Dominguez et al. found similar finding in their respective study. In my present study observed that the correlation between Hba1c and magnesium, VLDL and magnesium, was negative, & TC and magnesium, TG and magnesium, HDL and magnesium, LDL in magnesium was positive in group-1. Similar findings were obtained in the CARDIA study, during a 20-year follow-up, which also confirmed the reverse relationship of dietary Mg with inflammation markers We found that significantly higher proportion (78.8%) of patients having HbA1c ≥7% had hypomagnesemia as compared to those having HbA1c <7% in which 21.2% had hypomagnesemia. In addition, there was a significant negative correlation between S. Mg and HbA1c level ($r = -0.499$, $P = 0.001$), which is similar to study by Aksit et al. ($r = 0.332$, $P < 0.001$ respectively) and Yossef et al,[14] ($r = 0.569$, $P < 0.0001$ respectively). In other studies, Wahid et al. and Kumar et al reported significant difference in HbA1c values of diabetics with low and normal magnesium levels ($P < 0.0001$). Aksit et al, yossef et al. observed similar finding in their respective study.Naresh kumar Jha; study of lipid profile & electrolyte level in diabetes, study showed that a physically active lifestyle is associated with a lower incidence of type-2 diabetes. Akinkughbe et al reported in a study that the prevalence of diabetic is more in people who are engaged in light physical activity work, Nyenwe et al study revealed that, less physical activity was significantly associated with increased risk for DM.[15] Abebe et al reported in a study inactivity were significantly associated with diabetes mellitus. Similar findings were reported by Arpaci et al,[16] Corica et al,[17] and Corsonello et al,[18] who found that diabetic patients with microalbuminuria or clinical overt proteinuria

ISSN(O): 2687-5365; ISSN(P): 2753-6556

showed a significantly low S. Mg compared to normoalbuminuria group. However, no significant difference was observed in odds of finding hypomagnesemia among patients with neuropathy as compared to those without (P > 0.05). Essential hypertension accounts for the majority of hypertension in individuals with diabetes, particularly those with Type-2 diabetes, who constitute more than 90% of people with a dual diagnosis of diabetes and hypertension.[19]Incomparison study by santoshgosavi,[20] sherwani et al,[21]Rosmee and Shyamalkoley,[22] clinical data analysis 70% diabetic patients were found to have dyslipidemia in hypertension in diabetes patients than hypertension in non-diabetes patient founding in agreement with the previous studies; who reported higher TC, TG, VLDL-C AND LDL-C values in diabetic patients except HDL-C. In diabetes, the body either fails to properly respond to its own insulin or does not make enough insulin, or both. This causes glucose to accumulate in the blood, often leading to various complications.[23] This result from absolute or relative impairment in insulin action or both,[24] also have disorder in fat metabolism as a result of obesity and abnormal insulin action, hypertension, elevated cholesterol (combined hyperlipidemia), and with the condition often termed metabolic syndrome.[25] In normoglycemic subjects, a carbohydrate moiety is attached to a small proportation of hemoglobin A, thus creating what is as called as glycosylated or glycated hemoglobin. It has three distinct fraction: A1a, A1b and A1c. The A1c fraction accounts for 60% of bound glucose. Non-diabetic individuals have HbA1c values in the range of 3-6%.

CONCLUSION

From my study there is a significant correlation between magnesium and various circulating lipid parameters. In the present study a significant difference in lipid parameters in two group's is ≤7.0%≥7.0% of HbA1c. This may indicate that HbA1c can be used as a potential biomarker for hypertension patients with type-2 diabetic mellitus in addition to glycemic control. Hence, early diagnosis can be accomplished through relatively inexpensive blood testing and may be utilized for screening high-risk patients with DM for timely intervention with lipid lowering drugs. The glycemic control of the patients has got a strong impact on the serum lipid profile levels and atherosclerosis, CVD and CHD including heart attack and stroke. Patients should be educated about regular monitoring of lipid profiles and if found to be abnormal, should control blood glucose and cholesterol very effectively. Thus, my present study clearly added value of HbA1c can be monitoring long-term glycemic control and as an indirect indicator of dyslipidemia in Type 2 diabetic patients. Furthermore, magnesium being directly correlated with HbA1c and lipid profile except HDLC and may be potential indirect predictor of CVD risk in type 2 DM, though future prospective, cohort studies should be done in larger diabetic populations to further confirm this.

REFERENCES

1. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995-2025 - Prevalence numerical estimate and projections. Diabetes Care 1998; 21:1414-31.
2. Phuong-Chi T. Pham, Phuong-Mai T. Pham, Son V. Pham, Jeffrey M. Miller, Phuong-Thu T. Pham Hypomagnesemia in Patients with Type 2 Diabetes Clin J Am Soc Nephrol 2007; 2: 366 –373.
3. B Mirrahimi, H Hamishehkar, A Ahmadi, M R Mirjalili et al. The efficacy of magnesium sulfate loading on microalbuminuria following SIRS: One step forward in dosing Daru. 2012; 20: 74.
4. Hans CP, Sialy R, Bansal D. Magnesium deficiency and diabetes mellitus. Curr Sci 2002;83:1456-63.
5. Paolisso G, Scheen A, D'Onofrio F, Lefèbvre P. Magnesium and glucose homeostasis. Diabetologia. 1990;33:511-4.
6. Takaya J, Higashino H, Kobayashi Y. Intracellular magnesium and insulin resistance. Magnes Res 2004;17:126-36.
7. Mario Barbagallo, Ligia J Dominguez Magnesium and type 2 diabetes World J Diabetes 2015; 6: 1152-1157.
8. Kareem I, Jaweed SA, Bardapurkar JS, Patil VP. Study of magnesium, glycosylated hemoglobin and lipid profile in diabetic retinopathy. Ind J Clin Biochem 2004;19:124-7.
9. International Expert Committee report on the role of the A1C assay in the diagnosis of diabetes. Diabetes Care 2009; 32:1327-34.
10. Gabby, K.H., Hasta, R.Breslow, J.L. Ellison, R.C., Bunn, H.F. et al. Glycosylated Hb and long term glucose control in D.M.J.Clin. Endocrinol. Metabol 44:859-864.
11. Prabodh S, Sripad DV, Chowdary NVS, Shekhar R. Hypertension and Dyslipidaemia in Type 2 Diabetes Mellitus patients of Guntur and Krishna districts in Andhra Pradesh, India. National J Lab Med. 2012;1(1):7-10.
12. Chen YY, Lin YJ, Chong E, Chen PC, Chao TF, Chen SA, et al. The impact of diabetes mellitus and corresponding HbA1c levels on the future risks of cardiovascular disease and mortality: a representative cohort study in Taiwan. PLoS One. 2015.
13. International Expert Committee report on the role of the A1C assay in the diagnosis of diabetes. Diabetes Care, 2009, 32:1327-133
14. Medalie, J.H.; Papier, C.M.; Goldbourt, U.; Herman, J.B. Major factors in the development of diabetes mellitus in 10,000 men. Arch. Intern. Med. 1975, 135, 811– 817.
15. Sears B and Perry M. The role of fatty acids in insulin resistance. Lipid Health Dis 2015; 14: 121.
16. Ninomiya, T.; Kubo, M.; Doi, Y.; Yonemoto, K.; Tanizaki, Y.; Rahman, M.; Arima, H.; Tsuryuya, K.; Iida, M.; Kiyohara, Y. Impact of metabolic syndrome on the development of cardiovascular disease in a general Japanese population: TheHisayamastudy.Stroke2007,38,2063–2069.
17. Chen, G.; McAlister, F.A.; Walker, R.L.; Hemmelgarn, B.R.; Campbell, N.R. Cardiovascular outcomes in framingham participants with diabetes: The importance ofbloodpressure.Hypertension2011,57,891–897.
18. Little RR. Recent progress in glycohaemoglobin (HbAIc) testing. Diabetes care, 200023:265-266.
19. Sears B and Perry M. The role of fatty acids in insulin resistance. Lipid Health Dis 2015; 14: 121.
20. Peterson KP, Pavlovich JG, Goldstein D, Little R, England J, Peterson CM. What is hemoglobinAlc? An analysis of glycatedhemoglobins by electrospray ionization mass spectrometry. Clin Chem. 1998;44(9):1951-8.
21. De Ferranti SD, de Boer IH, Fonseca V, Fox CS, Golden SH, Lavie CJ, Magge SN, Marx N, McGuire DK, Orchard TJ, Zinman B, Eckel RH. Type 1 diabetes mellitus and cardiovascular disease: a scientific statement from the

ISSN(O): 2687-5365; ISSN(P): 2753-6556

American Heart Association and American Diabetes Association. Diabetes Care. 2014;37(10):2843– 2863.
22. Maahs DM, Daniels SR, de Ferranti SD, Dichek HL, Flynn J, Goldstein BI, Kelly AS, Nadeau KJ, Martyn-Nemeth P, Osganian SK, Quinn L, Shah AS, Urbina E; American Heart Association Atherosclerosis, Hypertension and Obesity in Youth Committee of the Council on Cardiovascular Disease in the Young, Council on Clinical Cardiology, Council on Cardiovascular and Stroke Nursing, Council for High Blood Pressure Research, and Council on Lifestyle and Cardiometabolic Health Cardiovascular disease risk factors in youth with diabetes mellitus: a scientific statement from the American Heart Association. Circulation. 2014;130(17):1532–1558.
23. Joslin"s Diabetes Mellitus 14th Ed. Lippincott Williams & Wilkins Chapter 33: Pathophysiology and treatment of lipid disorders in diabetes, pp. 567-571.
24. Ganong WF. Review of Medical Physiology. 21 edition. Boston: McGraw Hill; 2003: 357, 358, 345-346, 306-308,340, 310-311, 573-576.
25. Betterridge DJ. Diabetic dyslipidemia. Diabetes Care 2000;2(Suppl 1) :31-36.

ISSN(O): 2687-5365; ISSN(P): 2753-6556