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CORRELATION BETWEEN SERUM MAGNESIUM AND LIPID PROFILE IN DIABETIC PATIENTS AND ITS ASSOCIATION WITH COMPLICATIONS.

Endocrinology

Dr. Pankaj Kumar Singh* Attending Consultant, Department of Emergency Medicine, Ruby General Hospital, Kolkata, India.*Corresponding Author

Dr. Dhaval Kumar Bhadja Consultant, Department of Genereal Medicine, Vadilal Sarabhai General Hospital, Ahemdabad.

Dr. Mohit Bhatnagar Attending Consultant, Department of Critical Care Medicine, Ruby General Hospital, Kolkata, India.

Dr. Mandeep Joshi Senior Resident, Department of General Medicine, Peerless Hospital and B.K. Roy Research Center, Kolkata, India

Dr. Shreya Verma DNB General Medicine Trainee, Peerless Hospital and B.K. Roy Research Center, Kolkata, India

ABSTRACT

Background and aim: The present study was conducted to evaluate serum Magnesium and lipid profile in diabetic patients and to find out any correlation between serum magnesium and lipid profile in diabetic patients and its association with complications. **Material and Methods:** In the present study, 70 diagnosed Type 2 diabetes mellitus patients aged >30 years attending Diabetic Outpatient and Inpatient Department at Vivekananda Polyclinic giving their consent for inclusion were considered to be included in the study as Cases. **Results:** In present the study, mean S. magnesium levels of patients with diabetic complications were found to be significantly lower (1.09±0.22 mg/dl) as compared to that of patients in whom no diabetic complications were seen (2.19±0.71) and this difference was significant statistically.**Conclusions:** In the diabetic population correlations of serum magnesium and Total cholesterol, triglyceride, LDL and VLDL were Mild while HDL was of moderate level. Among controls correlations of Serum Magnesium with Total cholesterol, triglyceride, LDL, VLDL, and HDL were found to be weak and not found to be statistically significant.

KEYWORDS

Serum magnesium, Cholesterol, LDL, VLDL and HDL.

INTRODUCTION

The prevalence of diabetes is increasing rapidly at an unprecedented pace around the globe[1]. The role of diabetes has moved over the past 30 years from being known as a moderate elderly condition to one of the main causes of morbidity and mortality affecting young and middle-aged people. It is important to remember that in all six populated continents of the planet, the incidence is growing.[2]

Diabetes is fast gaining the status of a potential epidemic in India with more than 62 million diabetic individuals currently diagnosed with the disease[3,4]. In 2000, India (31.7 million) finished second and third in the world with the largest number of people with diabetes mellitus, followed by China (20.8 million) and the United States (17.7 million). The prevalence of diabetes is estimated to double globally, from 171 million in 2000 to 366 million in 2030, with the highest rise in India, according to Wild et al. 2. It is estimated that up to 79.4 million people in India will suffer from diabetes mellitus by 2030, while China (42.3 million) and the United States (30.3 million) will also see substantial rises in those affected by the disease[2,5].

Urbanization has brought about several changes in the lifestyle in India like the consumption of excess calories and reduction in complex carbohydrates with increased the consumption of simple sugars and fats. An urban-rural difference in the prevalence rate was found indicating that the environmental factors related to urbanization had a significant role in increasing the prevalence of diabetes[6]. The prevalence of diabetes in the urbanizing rural population was found to be midway between the rural and urban populations[7].

Energy-saving methods of transport and labor have resulted in physical activity is severely reduced. One of the major factors associated with diabetes in this population is the sedentary lifestyle. It has also been noted that risk factors for cardiovascular diseases such as hypertension, glucose sensitivity, elevated insulin for two hours, dyslipidemia, and obesity are often clustered in urban Indian populations[8,9]. Obesity is one of the major risk factors for diabetes, yet there has been little research focusing on this risk factor across India[10]. India has a higher prevalence of diabetes relative to western countries, despite having lower overweight and obesity rates, indicating that diabetes will occur in Indians at a much lower body mass index (BMI) compared to Europeans[10,11].

Dyslipidemia is common in DM, as both insulin deficiency and resistance affect enzymes and pathways of lipid metabolism[12]. The lipoprotein abnormalities commonly present in type 2 diabetes include an abnormally high level of triglycerides (TG), a high proportion of small dense low-density lipoprotein cholesterol (LDL), increased levels of small dense low-density lipoprotein-cholesterol (LDL-C) low high-density lipoprotein cholesterol (HDL), decreased atheroprotective high-density lipoprotein-cholesterol (HDL-C) levels, and postprandial lipemia[13,14,15,16,17]. This lipid profile pattern in type 2 diabetes mellitus is called diabetic dyslipidemia.

Magnesium, the second most common intracellular cation, plays a fundamental role as a cofactor in various enzymatic reactions involving energy metabolism. It is also involved at multiple levels in insulin secretion, binding, and activity. Cellular magnesium deficiency can alter the activity of membrane-bound sodium-potassium ATPase[18] which is involved in the maintenance of gradients of sodium, potassium, and glucose transport.

Studies have shown that magnesium levels are lower in patients with diabetes compared with nondiabetic controls[19,20,21,22,23,24]. Hypomagnesemia has been associated with impaired glycemic control and also with multiple long-term complications of diabetes mellitus[20].

Magnesium deficiency also has a role in the perturbation of lipid metabolism in the non-uremic population, especially in diabetic patients[25,26]. Magnesium plays a role in the release of insulin and so Magnesium depletion has atherogenic potential. Magnesium supplementation may result in a beneficial effect on the lipid profile of diabetic patients[26,27]. So given all the above, the present study was undertaken to study the serum Magnesium and lipid profile in patients with type 2 diabetes mellitus and also to correlate serum Magnesium level and lipid profile in type 2 diabetes mellitus patients.

MATERIALS AND METHODS

The present cross-sectional study was conducted in collaboration with the Outpatient and Inpatient Department of Medicine, Vivekananda Polyclinic and Institute of Medical Sciences (VPIMS), Lucknow after obtaining approval of the institutional Ethics committee. All the

patients of type 2 DM diagnosed by the treating physician based on biochemical investigations as per WHO criteria were invited to participate in the study, randomly 70 patients fulfilling the inclusion criteria and not coming in the domain of exclusion criteria were included in the study as cases. Seventy normal healthy individuals of the same age group and socio-economic status elected as controls.

We are going to perform a study on Serum Magnesium tests in type 2 diabetes mellitus and its correlation with the Lipid profile. In previous studies, Serum magnesium and HDL were significantly lowered and all other Lipid profile levels were significantly higher.

All the patients of Type 2 diabetes mellitus patients aged >30 years attending the Diabetic Outpatient and Inpatient Department at Vivekananda Polyclinic giving their consent for inclusion were considered to be included in the study as Cases.

The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 15.0 statistical Analysis Software. The values were represented in Number (%) and Mean±SD.

RESULT

The present study was conducted in the Outpatient and Inpatient Department of Medicine, Vivekananda Polyclinic and Institute of Medical Sciences (VPIMS), Lucknow to evaluate serum Magnesium and lipid profile in diabetic patients and to find out any correlation between serum magnesium and lipid profile in diabetic patients and its association with complications.

In the present study, 70 diagnosed diabetic patients attending the department were included as Group I while other 70 healthy control subjects of similar age were included as Group II. Distribution of study population was as under:

Table 1: Distribution of Study Population

	Description	No. of subjects	Percentage
Group I	Cases diagnosed as diabetic	70	50.00
Group II	Normal healthy Controls	70	50.00
	Total	140	100.00

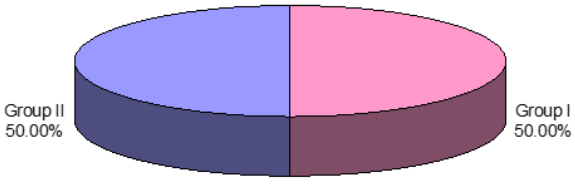

Figure 1: Distribution of Study Population

Table 2: Comparison of Age in Study Population

Age Group (years)	Overall (N=140)		Group I (n=70)		Group II (n=70)	
	No.	%	No.	%	No.	%
40-49	48	34.29	24	34.29	24	34.29
50-59	40	28.57	19	27.14	21	30.00
60-69	32	22.86	16	22.86	16	22.86
70-80	13	9.29	8	11.43	5	7.14
>80	7	5.00	3	4.29	4	5.71
			x^2=0.935 (df=4); p=0.919			
Minimum age	40		40		40	
Maximum age	82		81		82	
Median	55		55		55	
Mean	56.54		56.83		56.24	
S.D.	11.10		11.33		10.94	

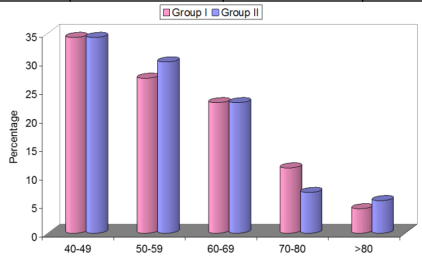

Figure 2: Comparison of Age in Study Population

Age of subjects enrolled in the study ranged from 40-82 years. Age of majority of subjects in overall population was between 40-59 years (62.82%) as well as in Group I (61.43%) and Group II (64.29%). Difference in age of Group I and Group II subjects was not found to be statistically significant (p=0.919). Median age of subjects of Group I and Group II was found to be 55 years.

Mean age of subjects included as cases was 56.83±11.33 years while that of controls was 56.24±10.94 years.

Table 3: Comparison of Gender in Study Population

Gender	Overall (N=140)		Group I (n=70)		Group II (n=70)	
	No.	%	No.	%	No.	%
Female	55	39.29	27	38.57	28	40.00
Male	85	60.71	43	61.43	42	60.00
			x^2=0.030 (df=1); p=0.863			

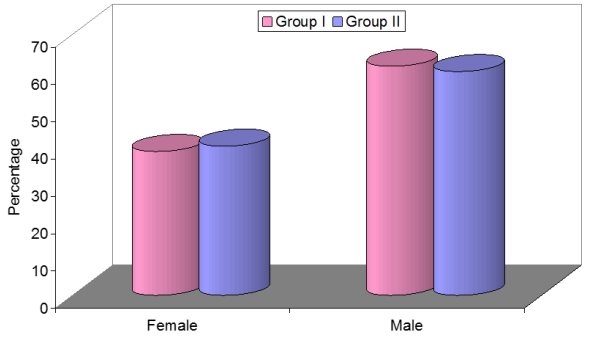

Figure 3: Comparison of Gender in Study Population

Out of 140 subjects included in the study, 55 (39.29%) were females and rest 85 (60.71%) were males. Female: Male ratio in the study was 1:1.55. Between group difference in gender of study population was not found to be statistically significant (p=0.863).

Table 4: Comparison of Serum Magnesium levels (mg/dl) in Study Population

	Overall (N=140)	Group I (n=70)	Group II (n=70)
Minimum	0.7	0.7	1.3
Maximum	4.3	3.6	4.3
Median	2.21	2.05	2.50
Mean	2.23	1.97	2.48
S.D.	0.70	0.78	0.50
		't'=4.556; p<0.001	

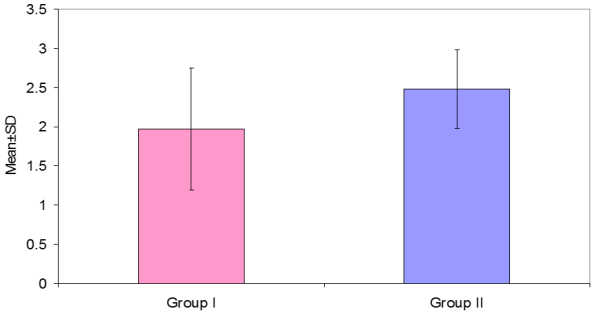

Figure 4: Comparison of Serum Magnesium levels (mg/dl) in Study Population

Range of Serum magnesium level of subjects of Group I was 0.7-3.6 mg/dl while that of Group II was 1.3-4.3 mg/dl. Median serum magnesium levels of Group I was 2.05 mg/dl and that of Group II was 2.50 mg/dl.

Mean serum magnesium levels of Group II (2.48±0.50 mg/dl) was found to be higher than that of Group I (1.97±0.78 mg/dl) and difference in mean serum magnesium levels of above two groups was found to be statistically significant (p<0.001).

Table 5: Comparison of Serum Magnesium in Study Population

Serum Magnesium level	Overall (N=140)		Group I (n=70)		Group II (n=70)	
	No.	%	No.	%	No.	%

Normal	109	77.86	43	61.43	66	94.29
Below normal	31	22.14	27	38.57	4	5.71
			x^2=21.918(df=1); p<0.001			

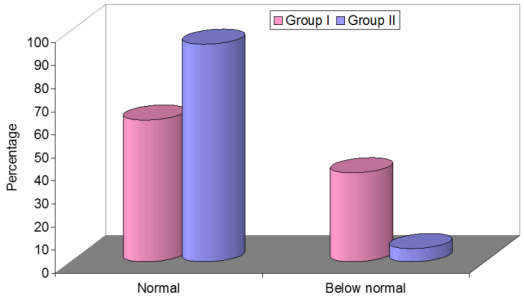

Figure 5: Comparison of Serum Magnesium in Study Population

Out of total 140 subjects included in the study, serum magnesium levels were found to be normal in 109 (77.86%) and in rest of the subjects serum magnesium levels were found to be below normal. Proportion of subjects with serum magnesium levels below normal in Group I (38.57%) was found to be higher than that in Group II (5.71%) and this difference was found to be statistically significant (p<0.001).

Table 7 shows the comparison of lipid profile of subjects in above two groups.

Table 6: Comparison of Lipid Profile and Statin use in Study Population

	Group I (n=70)		Group II (n=70)		Statistical significance ('t' test)	
	Mean	S.D.	Mean	S.D.	't'	'p'
Total Cholesterol	204.63	27.50	167.43	21.98	8.840	<0.001
Triglycerides	166.71	39.90	118.99	28.61	8.133	<0.001
LDL	135.43	23.26	95.70	18.58	11.165	<0.001
VLDL	33.40	7.96	23.81	5.77	8.156	<0.001
HDL	35.80	6.02	47.91	10.51	-8.370	<0.001

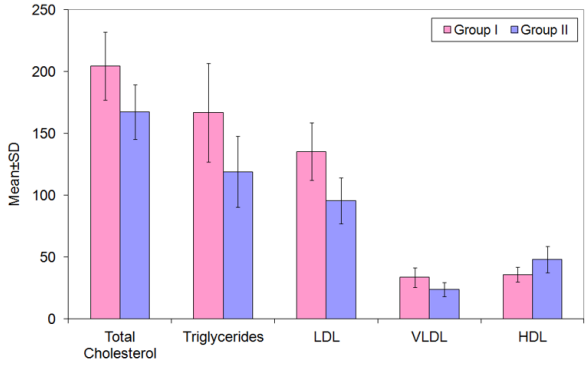

Figure 6: Comparison of Lipid Profile of Study Population

Total cholesterol of subjects of Group I (204.63±27.50 mg/dl) was found to be higher than that of Group II (167.43±21.98 mg/dl) and this difference was found to be statistically significant (p<0.001).

Similarly, Triglyceride levels of subjects of Group I (166.71±39.90 mg/dl) was found to be higher than that of Group II (118.99±28.61 mg/dl) and this difference was found to be statistically significant.

LDL and VLDL levels of subjects of Group I (135.43±23.26 mg/dl & 33.40±7.96 mg/dl) were found to be higher than that of Group II (95.70±18.58 mg/dl & 23.81±5.77 mg/dl). Between group difference in LDL levels and VLDL levels (p<0.001) were found to be statistically significant.

HDL levels of Group II (47.91±10.51 mg/dl) was found to be higher than that of Group I (35.80±6.02 mg/dl) and this difference was also found to be statistically significant (p<0.001).

Table 7: Complications in Diabetic Population (Group I)

	No. of subjects	Percentage
Complications present	14	20.0
No complications	56	80.0

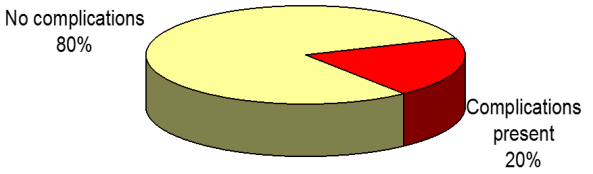

Figure 7: Complications in Diabetic Population (Group I)

All the subjects in Group II (Controls) were healthy subjects and no medical complication was found in these subjects. Out of 70 subjects of Group II, no complication was found in 56 (80.0%) subjects while rest 14 (20.0%) subjects reported nephropathy, ACS, Retinopathy, neuropathy or combination of above complications.

Table 8(a): Correlation of Serum Magnesium and Lipid Profile (N=140)

	R	p	Level of correlation
Total cholesterol	-0.472	<0.001	Mild
Triglycerides	-0.385	<0.001	Mild
LDL	-0.412	<0.001	Mild
VLDL	-0.349	<0.001	Mild
HDL	0.324	<0.001	Mild

Correlation of Serum magnesium levels in overall population with lipid levels (Total cholesterol, Triglyceride, LDL, VLDL and HDL) was found. Level of correlation was mild for all the above lipid variables. Inverse correlation was found with all lipid variables except HDL.

Table 8(b): Correlation of Serum Magnesium and Lipid Profile in Diabetic Population (Group I; n=70)

	R	P	Level of correlation
Total cholesterol	-0.346	0.003	Mild
Triglycerides	-0.334	<0.001	Mild
LDL	-0.426	<0.001	Mild
VLDL	-0.331	<0.001	Mild
HDL	0.502	<0.001	Moderate

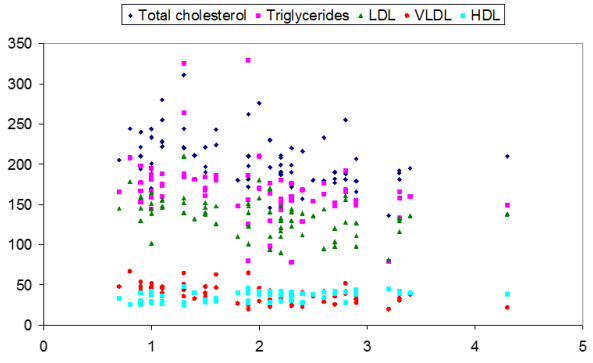

Figure 8: Correlation of Serum Magnesium and Lipid Profile in Diabetic Population (Group I; n=70)

In diabetic population an inverse and statistically significant correlation between total cholesterol and Serum magnesium levels was found, level of correlation was found to be Mild (r=0.3460).

In diabetic population an inverse and statistically significant correlation between Triglycerides levels and Serum magnesium levels was found, level of correlation was found to be Mild (r=0.334).

In diabetic population an inverse and statistically significant correlation between LDL levels and Serum magnesium levels was found, level of correlation was found to be Mild (r=0.426).

In diabetic population an inverse and statistically significant correlation between VLDL levels and Serum magnesium levels was found, level of correlation was found to be Mild (r=0.331).

In diabetic population statistically significant correlation between HDL levels and Serum magnesium levels was found, level of correlation was found to be Mild (r=0.502).

Table 9: Association of Complications of Serum and Lipid Variables in Diabetic Population

	No complication (n=56)		Complications present (n=14)		Statistical significance ('t' test)	
	Mean	S.D.	Mean	S.D.	't'	'p'
Total Cholesterol	198.52	23.72	229.07	28.82	-4.127	<0.001
Triglycerides	158.73	34.83	198.64	44.13	-3.631	0.001
LDL	129.45	20.71	159.36	16.97	-4.994	<0.001
VLDL	31.80	6.92	39.79	8.88	-3.642	0.001
HDL	37.27	5.11	29.93	5.98	4.647	<0.001
S. Magnesium	2.19	0.71	1.09	0.22	5.707	<0.001

Difference in all the above variables between subjects without complications and with complications was found to be statistically significant. All the above variables except S. Magnesium and HDL levels were found to be low in subjects with complications as compared to those without complications.

DISCUSSION

In present study, mean S. magnesium levels of patients with diabetic complications were found to be significantly lower (1.09±0.22 mg/dl) as compared to that of patients in whom no diabetic complications were seen (2.19±0.71) and this difference was significant statistically. Similar observations have been made by several researchers. In present study, patients having diabetic complications had nearly half S. magnesium levels as compared to that of patients without complications. In different studies this ratio has been shown to vary. Table 10 shows ratio of mean S. magnesium levels in patients with diabetic complications as compared to that of patients in whom no complications were seen as observed in different contemporary studies:

Table 10: Ratio of Mean S. Magnesium levels of Diabetic cases with complications as compared to those not having complications in different contemporary series

SN	Author Year	S. Magnesium level (mg/dl)		Ratio (With complications/ without complications)
		With complications	Without complications	
1.	Kareem *et al.* (2004) [19]	1.2±0.38	2.13±0.32	0.56
2.	Dayanand *et al.* (2011)[28]	1.43±0.17	2.16±0.28	0.66
3.	Khubchandani and Sanghani (2013)[24]	1.32±0.28	1.94±0.25	0.68
4.	Sajjan *et al.* (2014) [29]	1.5±0.30	1.76±0.34	0.85
5.	Yadav *et al.* (2016)[30]	1.1±0.47	2.03±0.34	0.54
6.	Present study (2016)	1.09±0.22	2.19±0.71	0.48

An overview of Table D2 above indicates that the ratio of S. magnesium levels between diabetic patients with complications and without complications ranged from 0.48 (Present study) to 0.85 (Sajjan *et al.*, 2014)[29]. The findings of the present study are near those observed by Yadav *et al.*[30] who reported this ratio to be 0.54. In all the series, the ratio of mean S. magnesium levels of cases with complications was significantly lower as compared to that of patients without complications. These findings in turn establish that magnesium has a very important role in governing bodily mechanisms. It is known that Mg's physiological function is mainly related to enzyme activity; over 300 enzyme systems depend on the presence of this cation, especially kinases. It also plays a role in homeostasis. Considering these relationships of magnesium with diabetes and diabetic complications. It is noteworthy to mention here that the role of magnesium in complications such as nephropathy, glaucoma, wound healing and coronary heart disease has also been elucidated. Hence, magnesium can be perceived to have an independent causal relationship with diabetes and its complications. It might be assumed that magnesium deficiency might affect insulin resistance as well as other microvascular and macrovascular complications. This causal relationship to some extent helps to explain the coexistence of diabetes and complications as well as the independent existence of different complications. The complex relationship of magnesium with health needs to be studied further.

CONCLUSION

The present study was conducted to evaluate serum Magnesium and lipid profile in diabetic patients and to find out any correlation between serum magnesium and lipid profile in diabetic patients and their association with complications. In the present study, 70 diagnosed diabetic patients and 70 healthy controls. Key findings of the present study were:

- Serum magnesium levels of Diabetic patients (1.97±0.78 mg/dl) were found to be significantly lower than that of non-diabetic patients (2.48±0.50 mg/dl).
- Serum magnesium levels of more than one-third of diabetic patients (38.57%) and only 5.71% of non-diabetic patients (Controls) were found to be below normal (difference statistically significant).
- Statistically significant differences in lipid levels (Total cholesterol, triglycerides, LDL, VLDL, and HDL) among diabetic and non-diabetic (Controls) were found.
- Differences in VLDL levels among diabetic patients and controls were not found to be statistically significant. Only 25.71% diabetic and 84.29% of controls had VLDL levels within desirable limits.
- Only 20.0% of diabetic subjects were suffering from other complications such as nephropathy, ACS, Retinopathy, neuropathy, or combinations of the above complications.
- Mild correlations of serum magnesium and lipid levels (Total cholesterol, triglycerice, LDL, VLDL and HDL) were found.
- In the diabetic population correlations of serum magnesium and Total cholesterol, triglyceride, LDL, and VLDL were Mild while with HDL was of moderate level.
- Among controls correlations of Serum Magnesium with Total cholesterol, triglyceride, LDL, VLDL and HDL were found to be weak and not found to be statistically significant.

The findings of the present study showed a deterministic role of magnesium in the causation of diabetes and its complications. The findings showed a cause-effect relationship of magnesium in different disease states. The findings of the present study corroborate the findings in previous studies and stress the need for creating awareness regarding the use of magnesium in diabetes and generalized health.

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