A study of serum magnesium and dyslipidemia in type 2 diabetes mellitus patients

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Abstract

Background: Type 2 diabetes is a heterogeneous metabolic disease characterised by insulin resistance in peripheral tissue together with impaired insulin secretion. It affects more than 285 million peoples worldwide and estimated that it will affect more than 438 million by the year 2030. It is the leading cause of morbidity and mortality. Magnesium is an important intracellular cation. Hypomagnesaemia is associated with diabetes. Dyslipidemia is seen in Diabetes mellitus.
Objectives: To estimate serum magnesium and lipid profile in type 2 diabetes mellitus patients and controls. To correlate serum Magnesium level with lipid profile in type 2 diabetes mellitus patients**.**
Materials & methods: A total of 100 subjects were included, out of which 50 were cases and 50 were controls. Fasting blood sugar (FBS), serum magnesium and lipid profile were measured. Data was statistically analyzed using SPSS 17thversion**.**
Results: There was statistical significant difference of serum Magnesium levels 1.56mg/dI due to hyperglycemia induced osmotic diuresis , Total cholesterol (TC), Triglycerides, Low density lipoprotein(LDL) and High density lipoprotein(HDL) due to increased flux of free fatty acids to liver secondary to insulin resistance was observed in Type 2 diabetes when compared with healthy controls. Significant negative correlation was observed between serum magnesium with Fasting blood glucose, TC, Triglycerides and LDL. Significant positive correlation was observed between serum magnesium and HDL levels.
Conclusion: Hypomagnesaemia has role in perturbation of lipid metabolism in diabetics.

Keywords: Fasting Blood Sugar, Dyslipidemia, Serum Magnesium

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Introduction

Diabetes mellitus (DM) is a clinical syndrome characterized by hyperglycemia due to absolute or relative deficiency of insulin[1]. The two broad categories of Diabetes Mellitus are designated as type 1 and type 2. Type 1 diabetes is the result of complete or near total insulin deficiency. Type 2 diabetes is a heterogeneous group of disorders characterized by variable degrees of insulin resistance, impaired insulin secretion, and increased glucose production. Although the prevalence of both type 1 and type 2 DM is increasing worldwide, the prevalence of type 2 DM is rising much rapidly because of increasing obesity and reduced activity levels as countries become more industrialized. The chronic complications of DM affect many organ systems and are responsible for the majority of morbidity and mortality associated with the disease[2]. Identifying the risk factors for the development of type 2 diabetes is essential for primary prevention[3].

Magnesium (Mg^{++}) is an important intracellular cation that is distributed into three major compartments: mineral phase of bones (65%), intracellular space (34%) and extracellular fluid (1%)[4,5,6]. Magnesium serves as a cofactor for all enzymatic reactions that requires ATP for Kinases, activates neuromuscular excitability and cell permeability, regulates ion channels and mitochondrial function, and an important factor in both cellular and humoral immune reactions[7]. Intracellular Mg deficiency may affect the development of insulin resistance[8,9]. It has been demonstrated that low serum Mg level was strong and independent predictor of incident of type 2 diabetes. Hypomagnesemia will impair tyrosine kinase activity at insulin receptors and further it aggravates insulin resistance which leads to micro and macrovascular complications observed in diabetes, such as cardiovascular disease, retinopathy, neuropathy[9,10,11].

Dyslipidemia is one of the major risk factor for cardiovascular disease in diabetes mellitus. The characteristic features of diabetic dyslipidemia are a high plasma triglyceride concentration, low HDL cholesterol concentration and increased concentration of small dense LDL-cholesterol particles. The lipid changes associated with diabetes mellitus are attributed to increased free fatty acid flux secondary to insulin resistance[12]. Magnesium deficiency also has a role in the perturbation of lipid metabolism in the non-uremic population, especially in diabetic patients[5,6]. An

important characteristic of hyperlipidemia associated with Magnesium deficiency is accumulation of triglyceride- rich lipoproteins and a decrease in the concentration of HDL[8].

Insulin resistance has a central role in the development of diabetic dyslipidemia and the main cause of the three cardinal features of diabetic dyslipidemia is the increased free fatty acid release from insulin-resistant fat cells. The increased flux of free fatty acids into the liver in the presence of adequate glycogen stores promotes triglyceride production, which in turn stimulates the secretion of apolipoprotein B (ApoB) and VLDL cholesterol. The impaired ability of insulin to inhibit free fatty-acid release leads to enhanced hepatic VLDL cholesterol production, which correlates with the degree of hepatic fat accumulation[12].

Magnesium play a role in the release of insulin and so Magnesium depletion has atherogenic potential. Magnesium supplementation may result in beneficial effect on the lipid profile of diabetic patients[6]. So in view of all the above, the present study is 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. Objectives of the study were to estimate serum magnesium and lipid profile in type 2 diabetes mellitus patients and to correlate serum Magnesium level with lipid profile in type 2 diabetes mellitus patients.

Materials and Methods

This case control study was conducted at Basaveshwar Teaching & General Hospital, Gulbarga for a period of one year from January 2014 to January 2015, on 30 to 60yrs age matched 50 healthy subjects, 50 Type II diabetes mellitus without complications. Patients informed consent & Institutional Ethical clearance was obtained.

Sample Collection: Blood sample: 4 ml of overnight fasting venous blood was collected aseptically from antecubital vein for estimations. 1ml in fluoride containing tube & 3ml in plain tube. Serum was separated by centrifugation at 3000 rpm for 10 min and was stored at 4˚C to prevent bacterial action until analysis.

Materials: The present study included 100 subjects both male and female with mean age 53 ± 10 years. 50 healthy controls, 50 Type II diabetes (FBS > 126mg/dl, PPBS > 199mg/dl). Exclusion criteria includes age <30yrs & >60yrs, other diabetic complications, hypertension, liver diseases, gastroenteritis, lipid lowering drugs, diuretics and any other medications.

Methods: Estimations were done in Semiautoanalyser Erba Chem-7, Blood Glucose by GOD-POD method[13], Serum Magnesium by Chlorophosphonazo-III method[14,] Serum Total Cholesterol by CHOD-PAP method[15], Serum Triglycerides by GPO-PAP method[16], LDL was calculated by Friedwald's formula[17], Serum HDL by Immunoturbidimetric method[18.]

Statistical Analysis

The results were expressed as mean ± standard deviation. Student 't' test was used to compare mean values. Pearson's correlation coefficient for association between the parameters was done using the statistical package of social sciences (SPSS-17, Chicago, USA)

Results

Table-1 shows Mean and Standard Deviation for Fasting Blood Sugar of cases and controls were 163.64±51.47 and 88.44±11.85 respectively. Significant positive difference ($p<0.001$) was observed in relation to Fasting Blood Sugar in cases compare to controls. Mean and Standard Deviation for Serum Magnesium of cases and controls were 1.56±0.32 and 2.25±0.42 respectively. Significant positive difference ($p<0.001$) was observed in relation to Serum Magnesium in cases compared to controls. Table-2 shows Mean and Standard Deviation for Total Cholesterol of cases and controls were 213.42±61.07 and 154.56±27.08 respectively. Significant positive difference ($p<0.001$) was observed in relation to Total Cholesterol in cases compared to controls. Mean and Standard Deviation for Serum Triglycerides of cases and controls were 206.86±67.26 and 116.04±38.22 respectively.

Significant positive difference ($p<0.001$) was observed in relation to Serum Triglycerides in cases compared to controls. Mean and Standard Deviation for High density lipoprotein of cases and controls were 36.4±3.74 and 40.1±8.37 respectively. Significant positive difference ($p<0.001$) was observed in relation to High density lipoprotein in cases compared to controls. Mean and Standard Deviation for Low density lipoprotein of cases and controls were 136.29± 55.25 and 92.48±26.75 respectively. Significant positive difference ($p<0.001$) was observed in relation to Low density lipoprotein in cases compared to controls. Table-3 shows correlation of serum magnesium with FBS and lipid profile in cases and controls. Graph-1 depicts negative correlation between serum Mg and FBS in cases. Graph-2 depicts negative correlation between serum Mg and Total cholesterol in cases. Graph-3 depicts negative correlation between serum Mg and Triglycerides in cases. Graph-4 depicts positive correlation between serum Mg and HDL in cases. Graph-5 depicts negative correlation between serum Mg and LDL in cases.

Table 1: Comparison of serum FBS and Mg among cases and controls

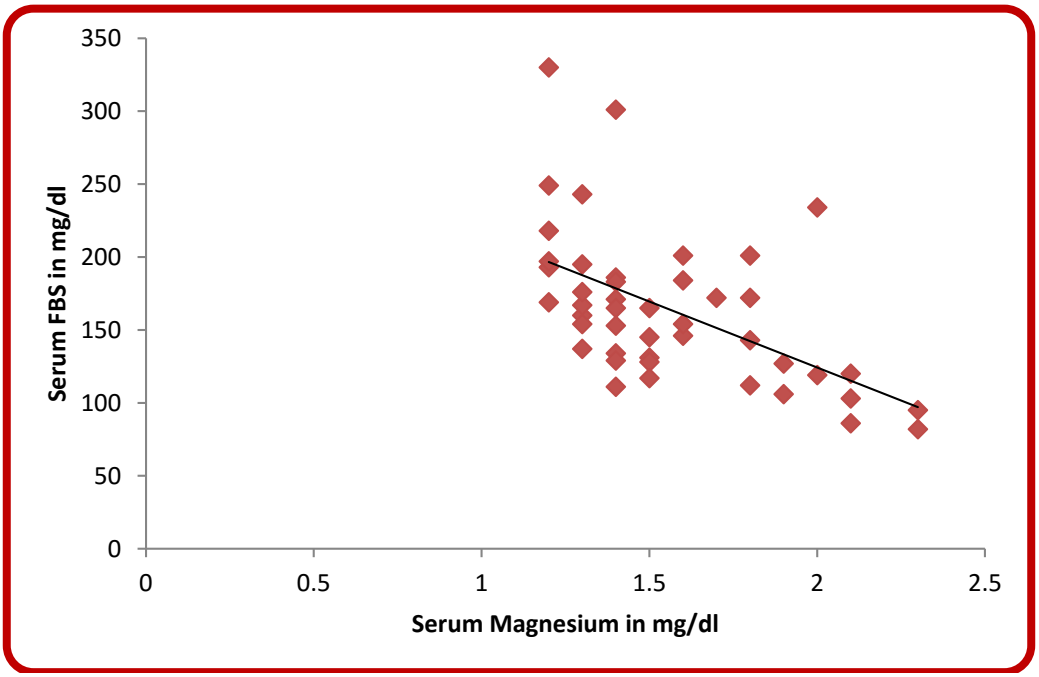
Parameters	Type 2 Diabetes mellitus cases	Normal Healthy Controls	p- value
Mean ± SD Fasting Blood Sugar (mg/dl)	163.64 ± 51.47	88.44 ± 11.85	P<0.001
Mean ± SD Serum Magnesium (mg/dl)	1.56 ± 0.32	2.25 ± 0.42	P<0.001

Table-2: Comparison of Lipid profile among Controls and Cases

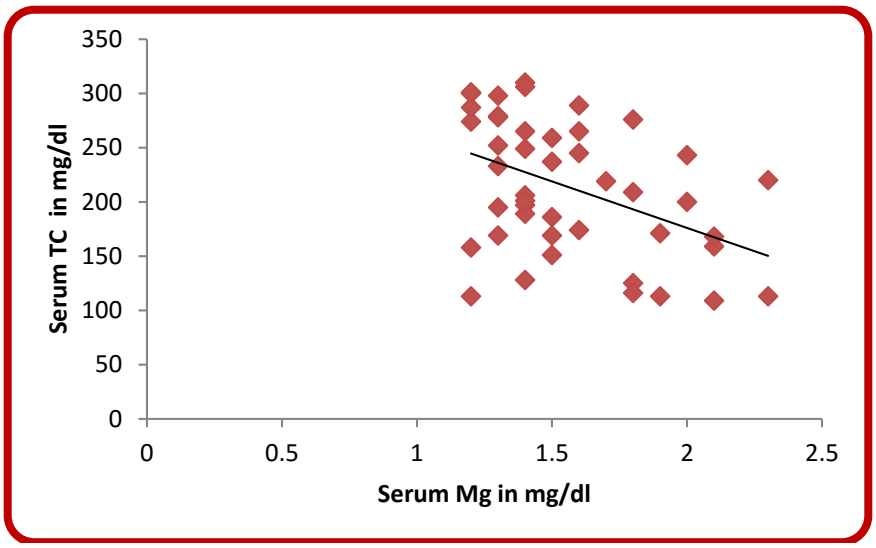
Lipid profile	Study group (Mean ± SD)	Control group (Mean ± SD)	t- test value	p-value
Total Cholesterol (mg/dl)	213.42 ± 61.07	154.56 ± 27.08	6.012	P<0.01
Triglycerides (mg/dl)	206.87 ± 67.26	116.04 ± 38.12	8.22	P<0.001
High density lipoprotein (mg/dl)	36.4 ± 3.74	40.1 ± 8.37	2.86	P<0.05
Low density lipoprotein (mg/dl)	136.28 ± 55.25	92.48 ± 26.75	5.046	P<0.01

Table 3: Correlation of serum Magnesium with FBS and Lipid profile in Cases and Controls

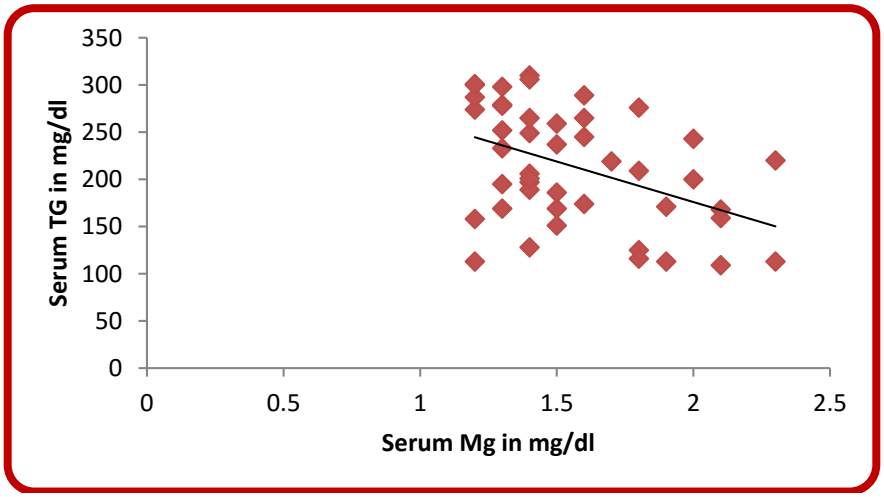
Parameters	Study group r value	p value	Control group r value	p value
FBS	- 0.546	<0.01	- 0.431	<0.01
TC	- 0.437	<0.01	-0.008	>0.05
TG	- 0.091	<0.05	- 0.173	>0.05
HDL	+ 0.024	<0.05	+ 0.120	>0.05
LDL	- 0.455	0.01	- 0.051	>0.05



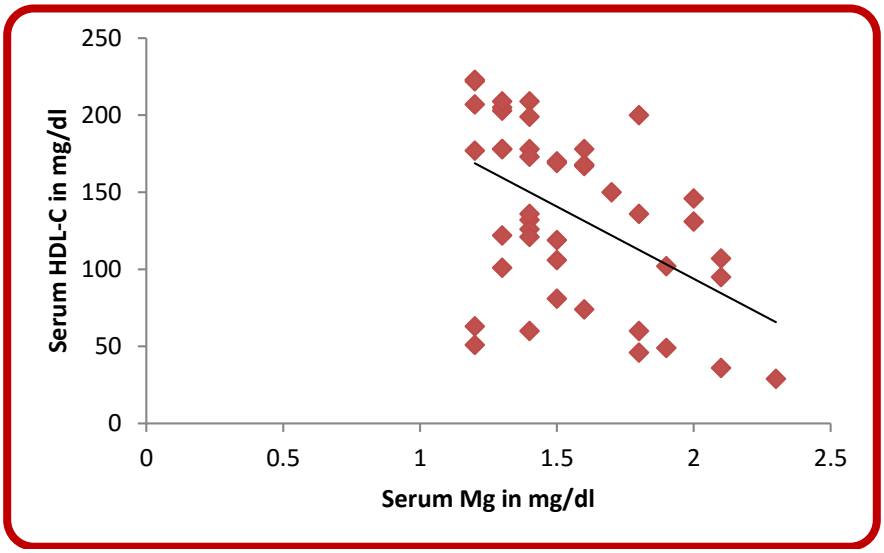
Graph 1: Correlation of Serum Mg with FBS in Cases



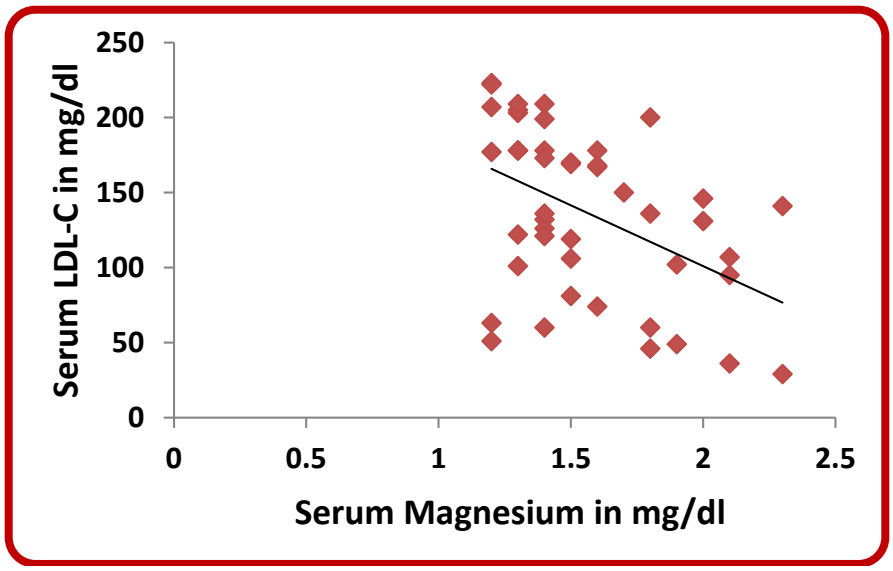
Graph 2: Correlation of Serum Mg with TC in Cases



Graph 3: Correlation of serum Mg with TG in Cases



Graph 4: Correlation of serum Mg with HDL-C in Cases



Graph 5: Correlation of serum Mg with LDL-C in Cases

Discussion

This work was done to study the association or relation of serum magnesium with lipid profile in Type 2 Diabetic mellitus. In our present study the serum values of Magnesium and lipid profile showed statistically significant difference when compared in healthy subjects and Type II Diabetes. The principle findings of the present study were significant negative correlation of serum Mg with serum cholesterol, Triglyceride and LDL & significant positive correlation of serum Mg with HDL were observed.

Magnesium is necessary for several enzymes that play an important role in glucose metabolism. The hypomagnesaemia in diabetic nephropathy due to Poor dietary intake, impaired absorption of magnesium, increased urinary loss due to hyperglycemia, osmotic diuresis, defective Mg reabsorption from renal tubules and loss of plasma protein bound Mg. Magnesium depletion is said to reduce the insulin sensitivity, thereby increasing the risk of secondary complications. Hyperglycemia leads to decreased cellular Mg levels. Hypomagnesaemia leads to collagen and ADP-induced platelet agreeability and also decreased function of Mg dependent enzymes, kinases and oxidative stress[19,20.] Magnesium deficiency also has a role in the perturbation of lipid metabolism of diabetic patients. Hypomagnesaemia inhibits prostacyclin receptor function, producing an imbalance between prostacyclin and thromboxane effects. Hypomagnesaemia can increase platelet reactivity, increase vascular and adrenal responses to angiotensin II, enhance thromboxane A2 (TXA2) release, and lead to organ damage from free radicals[21,22].

Hypomagnesaemia causes dyslipidaemia by decreasing activity of lipoprotein lipase, LCAT (Lecithin Cholesterol Acyl Transferase) and increasing HMG COA reductase enzyme. The lipid changes are attributed to increased Free Fatty Acids flux secondary to insulin resistance[23].

Lal et al and other studies have reported that Mean serum magnesium at baseline in the diabetic patients was significantly lower than that in controls. A significant fall in serum total cholesterol, LDL cholesterol and triglycerides and a rise in HDL cholesterol levels were observed 48 weeks after initiation of magnesium supplementation and continued till the end of the study i.e. 12 weeks and concluded that Mg supplementation resulted in a beneficial effect on the lipid profile of these patients[5].

Cristianae Hermes et al observed that inadequate metabolic control can affect the corporal concentration of Mg, developing hypomagnesemia which directly related with micro and macrovascular complications based on Cristiana's study, the supplementation of Mg has been suggested in patients with diabetes who have proven hypomagnesemia and presence of its complication[10].

In one of an Italian study shown that effect of 30 day period of magnesium supplementation, cholesterol level fell from 233 to 219 mg/dl, with fall in LDL from 156 to 140 and rise in HDL from 50 to 54[24].

Conclusion

Prevalence of hypomagnesemia is significantly higher in diabetics with compared to Controls. Hypomagnes-aemia has role in perturbation of lipid metabolism in diabetics. Regular monitoring of serum Magnesium & Lipid profile along with Magnesium supplementation in type 2 diabetes mellitus may prevent its progression to diabetic complications.

Conflict of Interest: None

Source of Support: Nil

References:

1. Boon NA, Colledge NR, Walker BR. Davidson's Principles and Practice of Medicine. 21 St edition; Elsevier Churchill Livingstone publications; 2010.
2. Fauci, Braunwald, Kasper, Hauser, Longo and Jameson et al. Harrison' s Principles of internal medicine.l8th edition; McGraw Hill medical publishing division; 2012.
3. Schulze MB and Ru FB. Primary prevention of Diabetes: What can be done and how much can be Prevented? Annual Rev Public health 2005; 26: 445-67.
4. Sasmita Mishra, P. Padmanaban, G.N. Deepti, G.Sarkar, S. Sumathi, B.D. Toora. Serum Magnesium and Dyslipidemia in Type-2 Diabetes Mellitus. Biomedical Research; 23 (2): 295-300.
5. Hamid Nasri, Hamid-Reza Baradaran. Lipids in association with serum magnesium in diabetes mellitus patients. Bratisl Lek Listy 2008; 109(7): 302-6.
6. Hamid Nasri. Lipids in association with serum magnesium in diabetes mellitus patients. Acta Angiol 2006; 12(4): 149-54.
7. Phuong-Chi T. Pham, Phuong-Mai T. Pham, Son V. Pham, Jeffery M. Miller and Phuong-Thu T. Pham. Hypomagnesemia in Patients with Type 2 Diabetes. Clinical journal of the American Society of Nephrology 2007; 2: 366-73.
8. Kenji Ueshima. Magnesium and ischemic heart disease: a review of epidemiological, experimental, and clinical evidences. Magnesium Research 2005; 18(4): 275-84.
9. Rasic-Milutinovic Z, Perunicic-Pekovic G, Pljexa S, Dangic A, Libek V, Bokan Lj, Cankovic-Kadijevic M. Magnesium deficiency in type 2 diabetes. Hippokratia 2004; 8(4): 179-81.
10. Cristiane Hermes Sales, Lucia de Fatima Campos Pedrosa. Magnesium and diabetes mellitus: Their relation. Clinical Nutrition 2006; 25: 554-62.
11. Monika K. Wältia, Michael B. Zimmermanna, Giatgen A. Spinasb, Richard F. Hurrel. Low plasma magnesium in type 2 diabetes. Swiss Med Wkly 2003; 133: 289-92.
12. Arshag D Mooradian. Dyslipidernia in type 2 diabetes mellitus. Nature Clinical Practice Endocrinology & Metabolism 2009; 5: 150-59.
13. Tietz, N.W. Fundamentals of Clinical Chemistry, W. B. Saunders Co., Philidelphia 1976: 919-20.
14. Allain C. C, Poon L.S, Chan C.S.G, Richmond W and Fu P. Clinical Chemistry 1974; 20: 470-71.
15. McGowan MW, et al. Clinical Chemistry 1983; 29: 538 - 39.
16. Rifal, N. and Warnick, G.R.Ed. Laboratory Measurement of lipids, lipoproteins and apolipoproteins. AACC Press, Washington, DC, USA 1994.
17. Schmidtz, A., et al. Diabetic Medicine 1988;5 (126): 112-17.
18. Haeckel, R. et al. Clinical Chemistry 1981; 27(1): 179-83.
19. Farah Aziz Khan, Mohd. Fareed Khan, et al. Estimation of serum copper and magnesium levels in diabetic nephropathy patients. Asian Journal of Biological and Life Sciences 2013; 2 (1): 23-26.
20. Vamsi Krishna Chittimoju and Sujatha Pasula. Study of serum magnesium, HBA1C and Microalbuminuria in diabetic retinopathy. International Journal of Pharma and Bio Siences 2013; 4(3): 501-09.
21. Hamid Nasri, Hamid-Reza Baradaran. Lipids in association with serum magnesium in diabetes mellitus patients. Bratisl Lek Listy 2008; 109(7): 302-06.
22. Hamid Nasri. Lipids in association with serum magnesium in diabetes mellitus patients. Acta Angiol 2006; 12(4): 149-54.
23. Arshag D Mooradian. Dyslipidemia in type 2 diabetes mellitus. Nature Clinical Practice Endocrinology & Metabolism 2009; 5: 150-59.