

Original Research Article

Correlation between serum magnesium levels and diabetic retinopathy in type 2 diabetes mellitus

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Received: 30 September 2019

Revised: 05 November 2019

Accepted: 13 November 2019

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ABSTRACT

Background: In this study, an attempt has been made to find the correlation between Diabetic Retinopathy (DR) and serum magnesium in type 2 Diabetic Mellitus (DM) cases.

Methods: Study was conducted in the department of General Medicine, GSL Medical College. Study protocol was approved by institutional ethical committee. All the non-critically ill type 2 DM individuals of all ages attended the outpatient services were included in the study. The reference range of Magnesium was taken as 1.7-2.4 mg/dL. Patients with low and normal Magnesium levels were categorized as cases and controls respectively. Statistical analysis was performed using SPSS software 21, Chi square test was used to compare the different qualitative variables; $p < 0.05$ was considered as statistically significant.

Results: A total of 163 individuals were included in the study, the mean age was 55.72 years, ranged between 39 to 75 years; male female ratio was 1.12. DR was diagnosed in 54% cases and low magnesium levels were detected in 40% cases; the difference was statistically not significant ($p > 0.05$).

Conclusions: Estimation of glycaemic levels and serum magnesium can help us predict the onset and progression of DR.

Keywords: Diabetes mellitus, Diabetes retinopathy, Magnesium, Serum

INTRODUCTION

Diabetes Mellitus (DM) is a complex metabolic disease caused by a variable interaction between hereditary and environmental factors. It is associated with considerable mortality from a variety of complications, which tend to worsen overtime and carries a significant premature mortality risk. Its main features are abnormal insulin secretion, high levels of blood glucose and variety of complications such as retinopathy, nephropathy, neuropathy and arteriosclerosis.^{1,2}

Diabetic Retinopathy (DR) is a sight threatening complication of DM and is one of the leading causes of acquired blindness in adults. The chance of losing the

sight is about 25 times higher compared to normal individuals. There are a series of risk factors related to the development and progression of DR such as duration of DM, poor glycemic control, dyslipidemia, hypertension and hypomagnesemia.^{1,3}

Hypomagnesemia has long been known to be associated with DM. Magnesium depletion is said to have a negative impact on glucose homeostasis and Insulin sensitivity. This association between DM and magnesium is said to have a wide range of impact on diabetic control and complications.^{4,5}

Chronic hyperglycemia and its associated non-enzymatic glycation plays an important role in the development of

microangiopathy. Intensive glycaemic control as measured by serum HbA1c levels have been demonstrated in randomized trials to reduce diabetic complications especially microvascular disease.⁶ Several studies have been done to study the influence of these individual risk factors on the progression of retinopathy. However, very few studies have been done to study the correlation between all these risk factors in diabetic patients with retinopathy.³

In this study, an attempt has been made to find the correlation between DR and serum magnesium in type 2 DM cases.

METHODS

Study was conducted in department of general medicine, GSL Medical College, Rajahmundry. Study protocol was approved by the institutional ethics committee. Informed written consent was taken from all the study participants. Study design was a cross sectional, hospital-based study. Study period was conducted from November 2015 to April 2017.

Study subjects

All the non-critically ill type 2 diabetes mellitus individuals (APACHE Score <10) of all ages, who attended the out-patient services in the department of general medicine, GSL medical college were considered in this study.

Study tools

A pretested and predesigned set questions were used to screen for the presence of type 2 diabetes mellitus in the individuals. Fasting and post prandial blood sugars were evaluated to confirm the diagnosis. Serum magnesium levels were assessed by photometric method. Ophthalmological evaluation was conducted in the patients. The reference range of magnesium was taken as 1.7-2.4 mg/dL. Patients with low and normal magnesium levels were categorized as cases and controls respectively.

Inclusion criteria

- Patients with type 2 diabetes mellitus for more than 5 years.

Exclusion criteria

- Critically ill individuals; patients on drugs known to affect serum magnesium levels such as Aminoglycosides, Amphotericin-B, Cetuximab, Cyclosporine, Digoxin, Diuretics (Loop, Osmotic, Thiazide); Patients with acute/chronic diarrhoeal and malabsorption states; Patients with Adrenal dysfunction; Patients with recent acidosis or sepsis;

Patients with vitamin or mineral supplementation in the present or recent past were excluded from the study.

Statistical analysis

Statistical analysis was performed using SPSS software 21, Chi square test was used to compare the different qualitative variables; $p < 0.05$ was considered as statistically significant.

RESULTS

A total of 163 non-critically ill type 2 diabetes mellitus individuals were included in the present study; in this 86 were female and 77 were male participants. The male female ratio was 1.12 (Table 1). The mean age of the study participants was 55.72 years and the age were ranged between 39 to 75 years.

Table 1: Gender distribution of the study population.

Gender	Frequency	Percent
Female	86	52.8
Male	77	47.2
Total	163	100.0

When eye condition was compared among males and females, it was observed that 58.1% of females had diabetic retinopathy (41.9% females had normal fundus) as compared to 49.4% of males with diabetic retinopathy (50.6% females had normal fundus). Upon performing chi square test, this difference between males and females with diabetic retinopathy and those with normal fundus was not found to be statistically significant ($p > 0.05$); (Table 2).

Table 2: Gender wise eye condition among the study participants.

Gender	Diabetic retinopathy	Normal fundus	Total
Female	50(58%)	36(42%)	86(100%)
Male	38(49.4%)	39(50.6%)	77(100%)
Total	88(54%)	75(46%)	163(100%)

Chi square= 1.263; $p=0.261$; statistically the difference was not significant

When magnesium levels were compared among cases with DR and those with normal fundus, it was observed that 48.9% of diabetic retinopathy patients were in the low magnesium group (51.1% were in the normal magnesium group) as compared to 28% of cases with normal fundus in the low magnesium group (72% were in the normal magnesium group). Upon performing chi square test, this difference between cases with diabetic retinopathy and those with normal fundus was found to be statistically significant ($p < 0.05$). DR was diagnosed in 54% cases and low magnesium levels were detected in 40% cases; the difference was statistically not significant ($p > 0.05$) (Table 3).

Table 3: Eye condition and magnesium levels.

Eye condition	Serum magnesium levels		Total
	Low	Normal	
Diabetic retinopathy	43(48.9%)	45(51.1%)	88(100%)
Normal fundus	21(28%)	54(72%)	75(100%)
Total	64(39.3%)	99(60.7%)	163(100%)

Chi square= 7.391; p=0.007 (Significant)

DISCUSSION

DM refers to a group of common metabolic disorders that share the phenotype of hyperglycemia. Several distinct types of DM exist and are caused by a complex interaction of genetics and environmental factors. Depending on the etiology of the DM, factors contributing to hyperglycemia include reduced insulin secretion, decreased glucose utilization, and increased glucose production. The metabolic dysregulation associated with DM causes secondary pathophysiological changes in multiple organ systems that impose a tremendous burden on the individual with diabetes and on the health care system. Insulin resistance and abnormal insulin secretion are central to the development of type 2 DM.⁷

DR was identified in 54% (88) individuals in this study. As per Narendran et al, study, DR was reported in 34% cases.⁸ Duration of DM is important factor, because if the duration of DM is long, the damage tissue damage also will be more. In the current report, the mean duration of DM was 12 years whereas in Narendra et al, report, the mean duration was 6 years. This is the main reason for more DR in this study. M Rema et al, reported that the risk of DR increases by 1.89 times for every five years increase in duration.^{9,10}

The findings of this studies show that 43 individuals among the 88 diabetics with retinopathy have low serum magnesium levels, which accounts for 48.9%. In comparison, among diabetics with normal fundus, 21 among 75 individuals have low magnesium levels, accounting for 28%.

Magnesium is the fourth most abundant cation in the body and second most prevalent intracellular cation. Magnesium is an obligate ion that is essential for the activation of many enzymes like the enzymes involved in glucose metabolism, fatty acid synthesis, and DNA and protein metabolism.¹¹ Hypomagnesemia has long been known to be associated with DM. Mather et al, confirmed the presence of hypomagnesemia in nearly 25% of their diabetic outpatients. It occurs at an incidence of 13.5-47.7% among patients with DM.^{4,12}

The link between hypomagnesemia and DR was reported.^{13,14} Patients with DR had lower serum magnesium levels when compared with their counterparts. They also found that serum magnesium

levels among the patients with DM had an inverse correlation with the degree of retinopathy.^{13,14}

Statistical analysis of this study shows significant difference between hypomagnesemia and DR, indicating that the prevalence of DR is more in individuals with decreasing serum magnesium levels, and the prevalence of hypomagnesemia is more in individuals with DR. This is explained by the fact that increased DR is seen in individuals with chronic hyperglycemia and chronic hyperglycemia induces GI and renal disturbances resulting in hypomagnesemia. Hypomagnesemia aggravates insulin resistance, resulting in elevated glycemic levels, and hence the vicious cycle continues.

CONCLUSION

From the results of the present study, it can be concluded that estimation of glycemic levels and serum magnesium can help us predict the onset and progression of DR.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Corrêa ZM, Freitas AM, Marcon IM. Risk factors related to the severity of diabetic retinopathy. *Arquivos Brasileiros de Oftalmologia*. 2003;66(6):739-43.
2. Chiarelli F, Mohn A, Tumini S, Trotta D, Verrotti A. Screening for vascular complications in children and adolescents with type 1 diabetes mellitus. *Hormone Res Paediatr*. 2002;57:113-6.
3. Manaviat MR, Afkhami M, Shoja MR. Retinopathy and microalbuminuria in type II diabetic patients. *BMC ophthalmol*. 2004;4(1):9.
4. 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(2):124.
5. Wälti MK, Spinass GA, Hurrell RF. Low plasma magnesium in type 2 diabetes. *Swiss Med Weekly*. 2003;133(1920).
6. Vijan S, Stevens DL, Herman WH, Funnell MM, Standiford CJ. Screening, prevention, counseling, and treatment for the complications of type II diabetes mellitus: putting evidence into practice. *J Gen Int Med*. 1997;12(9):567-80.
7. Jameson JL, Kasper D, Hauser S, Longo D. *Harrisons principles of internal medicine*. 19th ed. New York. McGraw-Hill Education. 2017.
8. Diabetic retinopathy among self-reported diabetics in southern India: a population-based assessment, 2014. Available at: <http://bjo.bmj.com/content/86/9/1014>. Accessed 22 January 2019.

9. Diabetic retinopathy: An Indian perspective 2009. Available at: <http://medind.nic.in/iby/t07/i3/ibyt07i3p297.pdf>. Accessed 4 May 2019.
10. Raman R, Ganesan S, Pal SS, Kulothungan V, Sharma T. Prevalence and risk factors for diabetic retinopathy in rural India. Sankara Nethralaya Diabetic Retinopathy Epidemiology and Molecular Genetic Study III (SN-DREAMS III), report no 2. *BMJ Open Diab Res Care.* 2014;2(1):e000005.
11. Parving HH, Mogensen CE, Thomas MC, Brenner BM, Cooper ME. Poor prognosis in proteinuric type 2 diabetic patients with retinopathy: insights from the RENAAL study. *Qjm.* 2005;98(2):119-26.
12. Fawcett WJ, Haxby EJ, Male DA. Magnesium: physiology and pharmacology. *Bri J Anaesth.* 1999;83(2):302-20.
13. Turecky L, Kupcova V, Szantova M, Uhlikova E, Viktorinova A, Czirfusz A. Serum magnesium levels in patients with alcoholic and non-alcoholic fatty liver. *Bratislavské Lekárske Listy.* 2006;107(3):58.
14. Pham PC, Pham PM, Pham SV, Miller JM, Pham PT. Hypomagnesemia in patients with type 2 diabetes. *Clini J Am Soci Nephrol.* 2007;2(2):366-73.

Cite this article as: Prasad NB, Sekhar AR, Meena K, Chandra TJ. Correlation between serum magnesium levels and diabetic retinopathy in type 2 diabetes mellitus. *Int J Adv Med* 2019;6:1859-62.