Section: General Medicine

Original Research Article

CORRELATION OF SERUM MAGNESIUM AND VITAMIN D LEVELS IN PATIENTS ATTENDING A TERTIARY CARE HOSPITAL

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Abstract

Background: Magnesium and vitamin D are essential for various physiological functions. Understanding their correlation can aid in better clinical management. Objectives: To evaluate the correlation between serum magnesium and vitamin D levels in patients attending a tertiary care hospital. **Materials and Methods:** A cross-sectional study involving 125 patients divided into three groups based on vitamin D levels: deficient (<20 ng/mL), insufficient (20-29 ng/mL), and sufficient (>29 ng/mL). Serum magnesium and vitamin D levels were measured and analyzed using Pearson's correlation coefficient. **Results:** Mean Vitamin D Levels: Deficient: 13.82 ± 3.09 ng/mL, Insufficient: 24.13 ± 2.31 ng/mL, Sufficient: 32.96 ± 2.33 ng/mL. Significant correlation observed between serum magnesium and vitamin D levels ($p < 0.05$). Deficiencies in both nutrients were associated with various health conditions. **Conclusions**: A significant correlation exists between serum magnesium and vitamin D levels in patients. Monitoring and managing both nutrients are essential for improving patient outcomes.

INTRODUCTION

In our bodies, nutrients collaborate harmoniously, each playing a vital role in maintaining our health and wellbeing. One nutrient can significantly influence the intestinal absorption efficiency of another, acting as a crucial limiting factor. Numerous bodily processes rely on the two vital nutrients—magnesium and vitamin D—to operate. Bone development and maintenance are impacted by magnesium's role in vitamin D activation, which in turn regulates calcium and phosphate balance.[1]

The majority of the enzymes that are involved in synthesis of vitamin D require magnesium as a cofactor. Skeletal abnormalities, cardiovascular disease, metabolic syndrome, and other conditions have been linked to deficiencies of these nutrients. For this reason, getting the full advantages of vitamin D requires making sure you take in the proper amount of magnesium.[1,2]

The steroidal vitamin D is a lipid-soluble nutrient that performs multiple molecular and cellular roles. In addition to bone mineralization, it has a major role in glucose metabolism, cellular differentiation and regeneration of numerous organs, and musculoskeletal homeostasis. Research has demonstrated that certain skeletal and non-skeletal illnesses can be mitigated with an adequate intake of vitamin D. Its inactive form (25[OH]D), cannot perform its biological tasks until converted to active form (1,25[OH]2D). Bioavailability of magnesium is critically important for these different vitamin D conversion steps.[1]

Skin synthesizes the majority of its vitamin D from 7-dehydrocholesterol when exposed to sunlight (>80%). Supplemental or dietary sources of vitamin D2 or D3 can also be used. According to studies, dysregulation can cause a variety of disorders that impact the brain system, musculoskeletal system, and cardiovascular system.

Supplements are unnecessary for people who get enough sunshine. Preventing vitamin D deficiency issues requires either safe exposure to sunshine or the ingestion of foodstuffs chemically supplemented with vitamin D, since most regular diets do not include enough of this nutrient.[2]

Biological action of vitamin D is negligible for both D3 (derived from animals) and D2 (derived from non-animals). Instead, the physiologically active form, 1,25-dihydroxyvitamin D (1,25[OH]2D), needs further processing in kidneys and liver. This process of activation happens in two stages: first, in the liver, the enzyme 25-hydroxylase converts cholecalciferol to 25-hydroxycholecalciferol

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(25[OH]2D); second, in the kidneys, the enzyme 1α hydroxylase converts 25- hydroxycholecalciferol to 1,25(OH)2D. It is magnesium that is necessary for the enzymatic activity of both these enzymes in liver and kidney. Among the several proteins that transport vitamin D in the blood, vitamin D-binding protein is by far the most important. Crucially, magnesium is also required for vitamin D-binding protein activity.3 By affecting production of active metabolites of vitamin D, magnesium plays a crucial role in mineralization of bones. There is a complex feedback loop between magnesium homeostasis in the body, which is controlled by the kidneys, the skeleton, and the intestines. You can get magnesium in a variety of forms, including foods, dietary supplements, and even some medications (such laxatives and antacids). Magnesium intake from whole foods has declined over the last several decades due to changes in eating habits and industrialized farming. Magnesium loss through perspiration and urine can occur with regular vigorous activity. Dietary shifts away from natural, unprocessed foods and towards processed fast food have contributed to the deficiency in magnesium.[4,5,6]
Magnesium is a "unheard and orphan nutrient‖ and requires no direct influence to be examined, so it has been conspicuously understudied. Cardiac disease, diabetes, migraine, asthma, osteoporosis, metabolic syndrome, hypertension, colon cancer, and sudden cardiac death have all been linked to magnesium shortage and low dietary consumption.[7-9]
One of the most neglected and unrecognized electrolyte abnormalities in modern medicine is hypomagnesemia. The majority of the enzymes that are involved in making vitamin D require magnesium as a cofactor. Therefore, the purpose of this research was to determine whether there is a correlation between serum magnesium and vitamin D levels.

MATERIALS AND METHODS

Type of Study: An observational study -CROSS **Sectional Study:** Study Period: 18 months
Study Setting: Department of General Medicine, Jubilee Mission Medical College, Thrissur
Sample Size: 125
Based on the correlation coefficient of serum magnesium and vitamin D observed in an earlier publication by Murudkar54 with 95 % confidence interval and 90% power minimum sample size comes to 125.

$$N = \left[\frac{Z_\alpha + Z_B}{C}\right]^2 + 3$$

C= 0.5*In[(1+r)/(1-r)]

Inclusion Criteria
Patients who have given written informed consent and age >18 years
Exclusion Criteria
1. Individuals taking Vitamin D, Magnesium and calcium supplements.
2. Patients with Chronic Kidney Disease, Chronic Liver disease, malabsorption syndromes and on Diuretics.

Tests Performed
Blood parameters like Serum magnesium, Vitamin D, Serum Calcium, Serum Phosphorus, Sodium, Potassium, LFT, RFT, RBS.
Methodology
Study was started upon approval from the ethics committee. Data was collected from patients attending medical outpatient departments and those admitted in medical wards and medicine intensive care units, who satisfy the exclusion and inclusion criteria. Subjects for the study were selected as per the treating Clinician's discretion after thorough History taking, physical examination and blood investigations.
The ECLIA method is used to assess vitamin D levels. The measurement range for 25 OH vitamin D Total is 8.1 to 126.0 ng/ml. A total vitamin D level of less than 20 ng/mL was deemed to be insufficient, a level between 20 and 29 ng/mL was deemed to be insufficient, and a level greater than 29 was deemed sufficient. A dry chemistry method employing the VITROS 5600 was used to determine the magnesium content of human serum. The parameter's analytical measurement range was 0.0–20.0 mg/dL. According to the kit documentation, the standard range for serum magnesium levels was 1.8–2.4 mg/dl. Appropriate quality assurance and calibration protocols were implemented. After collection of data, analysis was done as per plan.
Plan of Analysis
Data was entered to Microsoft excel and coded, further analyzed using IBM SPSS software version 25. Numerical variables were expressed as mean and SD. Correlation between serum magnesium and vitamin D analyzed using Karl Pearson coefficient of correlation. A p values of 0.05 or less was considered statistically significant.

RESULTS

Total 125 patients were divided into three groups based on Vitamin D levels:
GROUP A = Patients with Vitamin D below 20 ng/mL - Vitamin D deficiency
GROUP B = Patients with Vitamin D levels of 20 to 29 ng/mL - Vitamin D insufficiency
GROUP C = Patients with Vitamin D level >29 ng/mL - vitamin D Sufficient.

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1. Correlation between Serum magnesium - Vitamin D levels

Table 1: Linear regression analysis of Serum Magnesium-Vitamin D levels

Model	Unstandardized Coefficients	Standardized Coefficients				95% confidence interval for B	
	B	Beta	Standard error	T	p	lower bound	upper bound
(Constant)	1.86		0.02	81.87	<.001	1.81	1.9
GROUP A (Vitamin D deficiency)	-0.1	-0.29	0.04	-2.76	0.005	-0.18	-0.03
GROUP B (Vitamin D insufficiency)	0.1	0.26	0.04	2.76	0.007	0.03	0.18
GROUP C (Vitamin D Sufficient)	0.1	0.27	0.04	2.85	0.005	0.03	0.18

Linear regression analysis of serum magnesium levels with different groups of Vitamin D, The p value is <0.05 for all the groups, which means that we have evidence that all the three groups impact the dependent variable.

Table 2: Linear regression analysis of Serum magnesium and Vitamin D levels

Model	Unstandardized Coefficients	Standardized Coefficients				95% confidence interval for B	
	B	Beta	Standard error	T	p	lower bound	upper bound
(Constant)	1.8		0.04	42.34	<.001	1.72	1.88
VitD	0.01	0.26	0	2.93	.004	0	0.01

According to a linear regression analysis of serum magnesium and vitamin D levels, value magnesium changes by 0.01 units for every unit change in the value of the variable vitamin D. The dependent variable is impacted by vitamin D, as evidenced by the p-value of 0.004.

Table 3: Prevalence of Hypomagnesemia

Hypomagnesemia	YES		NO		P value
	No.	%	No.	%	
GROUP A (Vitamin D deficiency)	11	18.97%	47	81.03%	0.024
GROUP B (Vitamin D insufficiency)	1	2.78%	35	97.22%	
GROUP C (Vitamin D Sufficient)	2	5.56%	34	94.44%	
Total	14(10.77%)				

In our study, the prevalence of Hypomagnesemia was high among Group A (Vitamin D deficiency) patients i.e. 11(18.97%), compared to other two groups. (p =0.023).

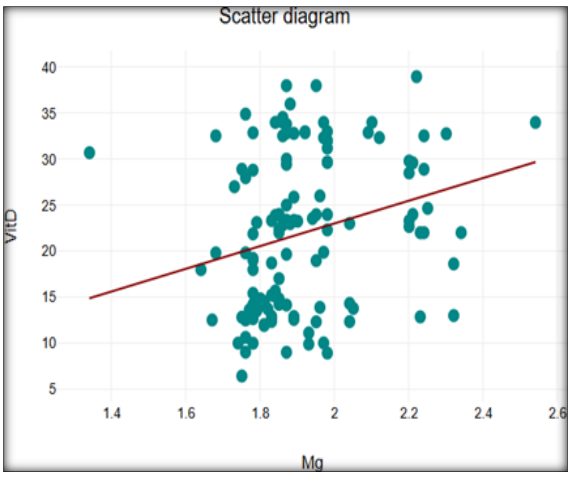

Figure 1: Prevalence of Hypomagnesemia

DISCUSSION

Our bodies need both magnesium and vitamin D for several processes. More than 600 enzymes, including those that activate and inactivate vitamin D, rely on magnesium as a cofactor. Magnesium consumption has declined in recent years as processed food consumption has increased. Abnormal vitamin D function has been associated with magnesium deficiency. Vitamin D's activation and inactivation are aided by magnesium.

Magnesium is also necessary for the development of vitamin D receptors for cellular effects and for vitamin D to bind to its transporter protein. Nonetheless, magnesium levels in the body can be impacted by vitamin D. Thus, magnesium absorption in the intestines can be enhanced by activated vitamin D. It appears that taking magnesium into account in addition to vitamin D is a sensible strategy to enhance vitamin D's physiological effects.

This Cross-sectional study was done for 18 months in the Department of General Medicine, Jubilee Mission

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Medical College, Thrissur. A total of 125 patients satisfying all inclusion criteria will be included in the study. Total 125 patients were divided into three groups based on Vitamin D levels. GROUP A had Patients with Vitamin D below 20 ng/mL - Vitamin D deficiency, GROUP B had Patients with Vitamin D levels of 20 to 29 ng/mL - Vitamin D insufficiency and GROUP C had Patients with Vitamin D level >29 ng/mL - vitamin D Sufficient.

DEMOGRAPHIC DETAILS

The mean age in GROUP A was 42.3 ± 14.01 years, in Group B was 45.41 ±15.71 years and in Group C was 49.74 ± 17.18 years. There is no statistically significant difference of age among three groups in our study. (p= 0.085). The mean age of our study population was 45.23 ± 15.6 years.

17(30.36,%), 14(41.18%) and 16(45.71%) were males, and 39(69.64%), 20(58.82%) and 19(54.29%) were females, respectively among Group A (Vitamin D deficiency), Group B (Vitamin D insufficiency) and in Group C (Vitamin D Sufficient). There is no statistically significant difference of gender distribution, among three groups. (p= 0.298).

We found that Females were more in Vitamin D deficient and insufficient groups. We observed that Hypertension was the most common comorbidity, followed by DM and DLP among the study population.

FBS AND SERUM CREATININE

The mean FBS was high in Group C (Vitamin D Sufficient) compared to the other two groups and it was significant. But serum creatinine level did not vary much among the 3 groups.

INCIDENCE OF FRACTURE

The incidence of pathological osteoporotic fractures in Group A (Vitamin D deficiency) was 5.36%, in patients of Group B (Vitamin D insufficiency) was 11.76%, and in Group C (Vitamin D Sufficient) was 11.43%. Even though Group B and Group C had higher percentage of fractures compared to Group A There was no statistically significance.

Sahota et al discovered that magnesium deficiency, together with low parathormone levels and a vitamin D deficiency, are significant contributing factors in patients with osteoporosis which was similar to our findings.[11]

According to Vázquez-Lorente et al the vitamin D status of the postmenopausal women in the was enhanced by magnesium supplements.[12]

CORRELATION BETWEEN SERUM MAGNESIUM AND VITAMIN D

According to a linear regression analysis of serum magnesium and vitamin D levels, value magnesium changes by 0.01 units for every unit change in the value of the variable vitamin D. The dependent variable is impacted by vitamin D, as evidenced by the p-value of 0.004.

Similarly, serum magnesium levels Group A was much higher compared to the Vitamin D deficient groups and this finding was statistically significant. Group A had 1.86mg/dl serum magnesium whereas it was 1.96mg/dl in the other two groups.

In a study by Hamid Nasri et al also found a strong positive link between serum magnesium levels and serum 25-hydroxyvitamin D levels.[13]

Roya et al. indicated that the group with hypovitaminosis D had a lower mean magnesium level, at 0.80 ± 0.23 mg/dl.52 They also found a significant positive correlation between the two. Magnesium and vitamin D showed positive association in a study by Murudkar also.[14]

But in contrast S. Kalyon et al,[15] discovered that there was no statistically significant correlation between magnesium and vitamin D levels. They suggested that individuals with vitamin D insufficiency or deficiency who were going to receive vitamin D therapy did not need to have a routine magnesium assessment which was contradictory to our finding.

CONCLUSION

Summary

This study investigated the correlation between serum magnesium levels and vitamin D levels. Findings indicate that there is strong positive correlation between serum magnesium and vitamin D levels. If the value of Vitamin D changes by one unit, the value of the Mg changes by 0.01 units.

The positive correlation observed may have significant implications for understanding the interdependent roles of magnesium and vitamin D in various physiological processes. Given the role of magnesium in the enzymatic activation of vitamin D, this relationship underscores the potential for magnesium supplementation to enhance vitamin status in populations at risk for deficiency.

The results highlight the importance of considering magnesium levels in the assessment and management of vitamin D deficiency. Future research should focus on the mechanistic pathways underlying this correlation and explore the clinical benefits of co-supplementation strategies. Additionally, longitudinal studies are needed to establish causality and further elucidate the potential health benefits for maintaining optimal levels of both magnesium and vitamin D.

Conclusion

In conclusion, the positive correlation between serum magnesium and vitamin D levels suggests a synergistic relationship that could inform nutritional guidelines and therapeutic interventions aimed at improving overall health outcomes

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