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COMPARATIVE STUDY OF BONE MINERALS IN PREDIABETIC PATIENTS AT TERTIARY CARE CENTER OF KOTA RAJASTHAN, INDIA

Biochemistry

Anukriti Chaudhary PhD Scholar & Senior Demonstrator, Department of Biochemistry, Government Medical College, Kota, Rajasthan

Ritu Sharma PhD Scholar & Senior Demonstrator, Department of Biochemistry, Government Medical College, Kota, Rajasthan

Gulab Kanwar Senior Professor, Department of Biochemistry, Government Medical College, Kota, Rajasthan

Swati Gupta Senior Demonstrator, Department of Biochemistry, Government Medical College, Kota, Rajasthan, SMS Medical College & Attached Group of Hospitals, Jaipur, Rajasthan

ABSTRACT

Objective: To determine serum level of bone minerals (serum calcium, phosphorus and magnesium level) in prediabetic subjects. **Methods:** The study was conducted a total of 162 subjects, assigned into 54 prediabetic cases and 108 of healthy controls enrolled from 2019 to 2021. Serum level of calcium, phosphorus and magnesium were analysed for both participants. The independent sample t-test was used to assess the association of serum level of bone minerals between prediabetic and control subjects. **Results:** The serum magnesium level in prediabetic patients was significantly lower than that in the control group ($p < 0.05$). While serum calcium and phosphorus level were remain unchanged. **Conclusion:** Our study findings suggest that lower circulating magnesium level are significantly associated to prediabetes. an early diagnosis of Mg level can be beneficial to prevent type II diabetes mellitus and further complications in future.

KEYWORDS

Prediabetes, IFG, IGT, Calcium, Phosphorus, Magnesium

INTRODUCTION

Prediabetes is characterized by blood glucose concentration raised than average defined as IFG, IGT, and mildly elevated HbA1c. However, the level is not high enough to be diagnosed with diabetes. [1]Prediabetics are at increase risk of development onset of diabetes and other macrovascular diseases such as CVD and stroke. The global prevalence of IGT in 2021 was 9.1% (464 million) and is projected to increase to 10.0% (638 million) in 2045. The global prevalence of IFG in 2021 was 5.8% (298 million) and is projected to increase to 6.5% (414 million) in 2045[2]. Prediabetic and diabetics are more prone to develop bone fragility, bone deformities, and joint disorders in future; it can be caused due to prolonged exposure of uncontrolled blood sugar. Bone minerals and trace elements are essential micronutrients required for the physiological functioning and many biochemical reactions.

Calcium is essential for insulin-mediated intracellular activities in insulin responsive tissues such as skeletal muscle and adipose tissue. [3] Insulin secretion is a calcium-dependent biological process and cytosolic calcium is used for insulin secretions in pancreatic β cells. Calcium homeostasis is impaired in diabetes and contributes to defective cell regulation[4]

Phosphate is needed for bone mineralization, energy balance, ATP generation and cellular structural components.[6] The serum phosphate level is regulated by intestinal phosphate absorption, renal phosphate handling and equilibrium of extracellular phosphate in bone or intracellular fluid.[18]

Magnesium (Mg) is an electrolyte of chief physiological importance in the body. 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, post receptorial impairment in insulin action and worsening of insulin resistance in diabetic patients.[17]

Recently, bone minerals have sparked interest in diabetes. Although, there is controversy in the result of increase or decrease or similar regarding bone minerals values, when exposed to healthy individuals. Very few studies have documented the mechanism underlying deterioration of bone health issue in prediabetics. So, the present study has been designed to evaluate the status of bone minerals in prediabetics and comparison of bone minerals between healthy subjects and prediabetics.

MATERIALS AND METHOD

This study was conducted on 162 subjects attending OPD of Government Medical College and Associated Group of Hospitals, Kota, Rajasthan. The study group was constituted by 54 newly diagnosed cases of prediabetic patients and 108 age & sex-matched healthy controls. The subjects with acute and chronic inflammatory conditions like infections, liver disease, kidney disease, known case of Diabetes Mellitus. Other systemic illness, Congestive heart disease and lipid lowering drugs were excluded from the study. A venous blood sample was collected for the estimation of fasting Glucose, 2hPG, calcium, phosphorus and magnesium, were measured by spectrophotometry method. The recommended criteria to diagnose prediabetes by American Diabetes Association (ADA) are HbA1c values between 5.7–6.4%, impaired fasting glucose (IFG) when the fasting plasma glucose (FPG) is between 100 to 125 mg/dL (5.6 – 6.9 mmol/L) 2hPG is between 140 mg/dL to 199 mg/dL (7.8 mmol/L-11.0 mmol/L) (American Diabetes Association 2014)(International Diabetes Federation 2021). Patient recruitment and study design were according to the institutional ethical committee (IEC) recommendations. The statistical analysis was performed using IBM SPSS 26 version software and Microsoft Excel, MS office 2011. A nonparametric statistical tool, the student *t*-test was used for comparing one variable between two independent samples (or groups) and the results were represented as mean ± SD. A *p*-value <0.05 was considered to be significant.

RESULTS

Table 1 describes the demographic characteristics of the prediabetic and healthy group. There was no significant difference regarding age and height but statistically significant difference was observed between weight and BMI values in prediabetics than in controls. Table 2 describes the fasting blood glucose level and 2hPG level in prediabetics. There was statistically significant difference was observed when compared to control group. ($p < 0.001$) Table 3 presents the bone minerals status of prediabetics and healthy controls. Our study did not show the statistically significant difference in serum calcium and serum phosphorus level between prediabetics and healthy controls (p=<0.423) (p=<0.328). In our study, significantly decreased serum magnesium was observed in prediabetic patients with healthy controls. (p<0.05)

Table 1: Anthropometric measurements of Prediabetics v/s Controls.

Parameters	Control	Pre-Diabetic	P value
Number	108	54	

Age (yrs.)	44.56±9.92	43.25±8.62	0.410
Height (m.)	1.63±0.08	1.63±0.09	0.222
Weight (kg)	64.58±11.23	80.26±9.82	<.001
BMI (kg/m^2)	24.14±2.85	29.99±2.89	<.001

Table 2: Comparison of fasting blood glucose & 2hPG level in prediabetics v/s control group.

Parameters	Control	Prediabetic	P value
Number	108	54	
Fasting blood sugar	85.72 + 12.7	111.7 +7.6	<0.001
2hPG	124.93 + 8.5	164.87 + 10.9	<0.001

Table 3: Comparison of serum calcium, phosphorus and magnesium level in prediabetics v/s control group.

Parameters	Control	Prediabetic	P value
Number	108	54	
Calcium	9.02 + 0.39	9.16 +0.28	<0.423
Phosphorus	3.24 + 0.26	3.25 + 0.26	<0.328
Magnesium	1.70 + 0.46	1.54 +0.54	<0.05

DISCUSSION

The present case control study was conducted on 162 subjects attended department of medicine in Government Medical College and Associated Group of Hospitals, Kota, Rajasthan, A tertiary care centre. The study group was constituted by 54 newly diagnosed cases of prediabetic patients and 108 age & sex-matched healthy controls.

Table 1 depicts the descriptive statistics of age, height, weight and BMI in patients and healthy controls. In our study, when compare with both groups of study subjects we did not observed significant difference between age and height. But we found significant difference between weight and BMI levels. (*p*- value < .001) We found elevated weight and BMI in prediabetic subjects than healthy controls. These results are consistent with previous studies that showed BMI and WC are strong predictors of T2DM. Marjani A, 2012 [18] also found that Type 2 diabetic patients had significantly increased waist circumference and body mass index.

Table 2 depicts the descriptive statistics of fasting Glucose and 2hPG in patients and healthy controls. In our study, when compare with both groups of study subjects we observed significantly elevated fasting blood Glucose and 2hPG in prediabetic subjects than healthy controls. (*p*- value < .001) Our results are consistent with studies by M Zhang. et al. (2017) and M Buysschaert et. al. (2014).[6,7] In the Prediabetes cells show sluggish or low response to insulin due to insulin resistance. However, pancreas produce more insulin to get the cells to respond. Due to insulin resistance blood glucose cannot be utilized by cells efficiently which causes high glucose level in blood, instead of entering in the cells which cause prediabetes and if it is untreated it ends up with type 2 diabetes.[5]

Table 3 presents the descriptive statistics for serum calcium in patients and healthy controls. Our study did not show any significant difference in serum calcium level between prediabetics and healthy controls (*p-value* 0.423). Although serum calcium was higher in some prediabetic patients but it did not achieve any statistically significant difference between prediabetic and healthy controls. Our results were parallel with Sorva A et.al. 1990 and Gulshan Quadri et.al. 2022[13,14]. Many studies have investigated the link between serum calcium and incident T2DM, reporting positive associations.[11,12] But in our study we did not find any significant difference between normal and prediabetic subjects in serum calcium level.

Table 4 presents the descriptive statistics for serum phosphorus in prediabetics and healthy controls. Our study did not show any significant difference in serum phosphorus level between both groups. (*p-value* 0.328). Our results were also line with Nasir Hamed et.al. 2013[8]. The serum phosphate level is regulated by intestinal phosphate absorption, renal phosphate handling and equilibrium of extracellular phosphate in bone or intracellular fluid. [15] The level of serum phosphate is not regulating only by deficiency in serum 25(OH) D levels, but also it is regulating by other factors. Hormones such as parathyroid hormone, 1, 25-dihydroxy vitamin D (1, 25 (OH)2 and fibroblast growth factor 23 (FGF23) regulate serum phosphate by modulating intestinal phosphate absorption, renal phosphate reabsorption and/ or bone metabolism. In addition, dietary phosphate rapidly enhances renal phosphate excretion, so serum phosphorus remain unvaried. Although, detailed mechanisms of this adaptation remain to be clarified.

Table 5 depicts the descriptive statistics of serum magnesium in prediabetic and healthy controls. In our study, significantly decreased serum magnesium was observed in patients than healthy controls. ($p<0.05$) Intracellular magnesium 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, post receptor impairment in insulin action, and worsening of insulin resistance in diabetic and prediabetic patients.[16,17]

CONCLUSION

The results of this study revealed alterations in serum magnesium in prediabetes but no change was observed in serum calcium and phosphorus levels. Thus, by regulation of serum magnesium level in prediabetics, we can prevent bone deformities. Hence, its early treatment could be beneficial to prevent further complications in bone metabolism.

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REFERENCES

1. Bansal N. Prediabetes diagnosis and treatment: a review. World J Diabetes. 2015;6(2):296-303.
2. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2014;37(1):81-90
3. Kanchana N, Saikumar P. Serum calcium levels in type 2 diabetes mellitus. J Dental Med Sci. 2014;13(8):01-3.
4. Curry, D. L., L. L. Bennett, and G. M. Grodsky. "Requirement for Calcium Ion in Insulin Secretion by the Perfused Rat Pancreas." The American Journal of Physiology 1968 214 (1): 174–78
5. Ying Lee C.M., Stephen Colagiuri, Mark Woodward, Edward W Gregg, Robert Adams,"Comparing different definitions of prediabetes with subsequent risk of diabetes: an individual participant data meta-analysis involving 76 513 individuals and 8208 cases of incident diabetes". BMJ Open Diab Res Care 2019.
6. M.Zhang -Ghani MA, Tripathy D, DeFronzo RA. "Contributions of beta-cell dysfunction and insulin resistance to the pathogenesis of impaired glucose tolerance and impaired fasting glucose". Diabetes Care 2006; 29:1130-1139.
7. Buysschaert, M., Baeck, M., Preumont, V., Marot, L., Hendrickx, E., Van Belle, A., & Dumoutier, L. Improvement of psoriasis during glucagon-like peptide-1 analogue therapy in type 2 diabetes is associated with decreasing dermal γδ T-cell number: a prospective case-series study. British Journal of Dermatology 2014, 171(1), 155–161.
8. Nasir Hamad, Linda Bashier Eltayeb, Sara Lavinia Brair, Khalid Hussein Bakheit, Hamdan Zaki Hamdan, Waleed Hussein Omer. A clinical study of serum calcium, phosphorus, and alkaline phosphates level in type II Diabetes mellitus among Sudanese population in Khartoum State, 2012. NMJ, JUNE 2013, vol.3 No. 10 ISSN 1858-627
9. Sabahelkhier MK, Mohammed KA, Ahmed Babikir and Khogali Elnur Ahmed Ishag Calcium, Magnesium, Phosphorus and Glucose Level Associated With Patients Suffering from Vitamin D Deficiency. Int J Biochem Physiol Volume 5 Issue 2.
10. Carlos Lorenzo, Anthony J. Hanley, Marian J. Rewers & Steven M. Haffner Diabetologia 2014 volume 57,1366–1374
11. Becerra-Tomás, N., Estruch, R., Bulló, M., Casas, R., Díaz-López, A., Basora, J., … Salas-Salvadó, J. "Increased Serum Calcium Levels and Risk of Type 2 Diabetes in Individuals at High Cardiovascular Risk". Diabetes Care 2014. 37(11), 3084–3091.
12. Kim, KN, Oh, SY & Hong, YC "Associations of serum calcium levels and dietary calcium intake with incident type 2 diabetes over 10 years: the Korean Genome and Epidemiology Study (KoGES)". Diabetol Metab Syndr 2018.
13. Sorva, A & Tilvis, RS "Low serum ionized to total calcium ratio: association with geriatric diabetes mellitus and with other cardiovascular risk factors". Gerontology 1990, 36, 212–216.CrossRefGoogle ScholarPubMed
14. Gulshan Qadri, Anil Kumar and Hare krishna Sharma "Comparative study of serum calcium, serum phosphorus and alkaline phosphatase between prediabetes and type-2 diabetes mellitus". International Journal of Advanced Biochemistry Research 2022; 6(1): 79-83
15. Lee, Ju Hee, Yun Hyeong Lee, Kyoung Hye Jung, Min Kyeong Kim, Hye Won Jang, Tae Kyun Kim, Hyun Jin Kim, et al. "Bone Mineral Density in Prediabetic Men." Korean Diabetes Journal 2010 34 (5): 294.
16. Mario Barbagallo and Ligia World J Diabetes. Aug 25; 6(10): 1152–1157.J Dominguez "Magnesium and type 2 diabetes". 2015.
17. Saris NEL, Mervaala E, Karppanen H, Khawaja JA, Lewenstam A. "Magnesium. An uptake on physiological, clinical and analytical aspects". Clin Chim Acta 2000;294:1–26
18. Abdoljalal Marjani. "A Review on Metabolic Syndrome." Journal of Endocrinology and Metabolism, Volume 2, Number 4-5, October 2012, pages 166-170