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Study on Serum Bone Minerals Level in Type 2 Diabetes Mellitus

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ABSTRACT

Diabetes mellitus represents a group of diseases of heterogeneous etiology, characterized by chronic hyperglycemia and other metabolic abnormalities, which are due to deficiency of insulin effect. Evidence for a disturbance of mineral metabolism in diabetes has accumulated since the eighties of the last decade. In the present study, a total of 40 cases and 25 controls were studied. A sample of venous blood was collected from each individuals included in this study. The present study shows that the diabetic type 2 patients have higher serum calcium levels, and lower magnesium levels compared to healthy individuals, while serum phosphate level was not affected.

KEYWORDS : Calcium, Phosphorus & Magnesium.

Introduction:

Approximately 97% of people who have diabetes mellitus have type 2 diabetes mellitus (DM)[1]. Evidence for a disturbance of mineral metabolism in diabetes has accumulated since the eighties of the last decade[2]. Diabetes mellitus represents a group of diseases of heterogeneous etiology, characterized by chronic hyperglycemia and other metabolic abnormalities, which are due to deficiency of insulin effect. Adults who have one or more first- or second-degree relatives affected with diabetes are at high risk of developing diabetes. The evidence is strong; however, that youth with a positive family history already show signs of increased risk for diabetes[3,4]. The incidence of diabetes type 2 is increasing at an alarming rate both nationally and worldwide with more than one million cases per year diagnosed in the US alone. Although our current methods of treating diabetes has improved but prevention is preferable[5]. The old concept of bone as inert metabolic tissue, with minor contributions to metabolic adaptations has been reconsidered in light of findings that bone is involved in the development of insulin sensitivity[6]. Bone metabolism is regulated by complicated mechanisms that involve mineral metabolism and endocrine systems[7].

Diabetes may influence the bone in multiple pathways, some with contradictory effects. These mechanisms include changes in insulin and insulinlike growth factors levels, hypercalciuria associated with glycosuria, obesity, higher concentrations of advanced glycation end-products in collagen etc. Along these lines, many cohort studies undeniably indicated that diabetes itself is associated with increased risk of osteoporosis[8,9]. Recent studies have indicated that bone cells contribute to metabolic activity by the production of peptides such as osteocalcin that impacts insulin sensitivity and energy metabolism[6].

It was shown that insulin and insulin like growth factors (IGF-1, IGF-2) have an influence on bone metabolism itself and other growth factors, cytokines and hormones may determine changes in diabetic bone metabolism[10].

There was a very strong dose-dependent relationship between duration of diabetes and risk of hip fracture in Asian population like their Western counterparts[11]. Early human diabetes mellitus can result in hypercalciuria and reduced bone mass (osteopenia).

Experimentally it is proved that altered mineral balance is due to the disturbances in pancreatic function. It is observed that bone of diabetic rats in the early stage of diabetes (32 days) loses magnesium, while the calcium and phosphorus content does not change significantly.

During longer persistence of severe diabetes (70 days) a significant drop of all three minerals in bone was observed. The bones of diabetic animals on the 70th experimental day were macroscopically smaller and were very fragile[12,13].

Diabetes mellitus is the also associated with secondary magnesium deficit. Plasma magnesium concentrations may correlate inversely with the degree of hyperglycaemia. Clinical studies have speculated on a potential link between the magnesium deficit of diabetes and several diabetic complications, including cardiovascular problems and retinopathy[14]. Early recognition and treatment of severe hypophosphatemia are important to reduce the risk of neurological complications[15]. Our aim was to evaluate the bone minerals (calcium, magnesium and phosphrus) serum levels in Indian patients with type 2 diabetes mellitus and compare it with normal healthy individuals.

Material and Methods:

The present study was conducted in Hi-Tech Medical College & Hospital Bhubaneswar, Odisha, India during the period from March 2011 to October 2011. The study protocol was approved by the Ethics committee of Hi-Tech Medical College & Hospital, Bhubaneswar. Randomly selected, 40 patients with newly diagnosed type 2 DM of both sexes who were attending Hi-Tech Medical College & Hospital, Bhubaneswar along with 25 healthy controls were included in this study. All participants gave written consent to participate in this study, all patients with type 2 diabetes mellitus were included, patients with history of parathyroid disorders, renal diseases and those who are on drugs that contain calcium, phosphate and magnesium were excluded. After informed consent, and use of antiseptic for the skin (70% alcohol), 5.0 ml of venous blood was collected from each individuals included in this study, the sample was transferred to a plane container, serum was separated after clot retraction by centrifugation and the serum transferred to a stopper vial for the determination of calcium, magnesium and phosphate levels by photometric system using automated chemistry analyzer Erba. Data were analyzed by SPSS student t-test and one way ANOVA. A P-value <0.05 was considered statistically significant.

Results and Discussion:

In the present study, a total of 40 cases and 25 controls were studied. Table:1 shows the concentration of calcium, Phosphorus & Magnesium between cases and controls.

Table 1 shows the comparison of calcium, Phosphorus & Magnesium between cases and controls:

Variables	Cases (N=40) (Mean±sd)	Controls (N=25) (Mean±sd)	P-Value
Age	56.0± 3.01	42.02 ± 0.9	0.0001
Calcium (mg/dl)	10.85 ± 0.01	8.12 ± 0.1	0.001
Phosphorus (mg/dl)	4.01 ± 0.02	3.12± 0.2	0.350
Magnesium (mg/dl)	1.31 ± 0.14	1.95 ± 0.1	0.001

*Statistically Significant (P <0.05)

The importance of the trace elements in living organisms was first shown over a century ago. Claude Bernard and McMunn (Quoted by Lamb et al)[16]. Minerals including calcium, phosphorus and magnesium have been identified as playing a potential role in the prevention of bone diseases, particularly osteoporosis. Prolonged supplementation of Ca and vitamin D in elderly has been shown to prevent bone loss, and in some intervention studies to prevent fragility fractures demonstrated the existence of a number of tracemetal- containing enzymes (metalloenzymes) of importance to the structural and functional integrity of the living cells[17]. Growing concern with environmental factors in human health over the last few years has aroused renewed interest in the trace elements. Abnormalities in their metabolism have been demonstrated in many human diseases. In particular, diabetes mellitus has been shown to be associated with abnormalities in the metabolism of calcium and magnesium16.

The common links among several clinical disorders including type 2 diabetes, the major findings made in the current study are the discovery of significant correlations between total serum calcium concentrations with fasting serum glucose, insulin resistance, and β-cell function in a large, healthy population. The results provide evidence that the variations in calcium metabolism, indexed by total serum calcium concentration, are related to measures of glucose metabolism[18,19,20].

Our study revealed that serum calcium was higher in the diabetic patients, Maestro B *et al* reported that vitamin D may have a beneficial effect on insulin action either directly, by stimulating the expression of insulin receptor thereby enhancing insulin responsiveness for glucose transport[20], or indirectly via its role in regulating extracellular calcium ensuring normal calcium influx through cell membranes and adequate intracellular cytosolic calcium [Ca^{2+}] pool. On studies carried out by Ojuka EO *et al* , Williams PF *et al* and Draznin B found that calcium is essential for insulin-mediated intracellular processes in insulin-responsive tissues such as skeletal muscle and adipose tissue [21,22] with a very narrow range of [Ca^{2+}] needed for optimal insulin-mediated functions.[23] Draznin B *et al* and Zemel MB *et al* reported that changes in [Ca^{2+}]i in primary insulin target tissues may contribute to peripheral insulin resistance[24,25] via impaired insulin signal transduction[24,25].

The increased levels of serum calcium in the recent study indicates that diabetes mellitus is a condition in which cell calcium homeostasis is impaired. The defects in cell calcium regulation were found in many tissues confirming that this defect in cell calcium metabolism is a basic pathology associated with a diabetic state, and may be significant for the observed pathologies in insulin secretion and insulin action in diabetes. The increase levels of serum calcium in type 2 diabetic patients may also play an important role in the vascular complications, such as hypertension, atherosclerosis, and microangiopathy[26].

Our findings shows there was insignificant of serum phosphate levels for the diabetic group compared to the control group in diabetes mellitus which is consistent with same findings revealed by Elseweidy et al[27]. Magnesium is known to be related to the carbohydrate and fat metabolism. Serum magnesium levels have been shown to be inversely related to the severity of diabetes[28]. Definite lowering of serum magnesium has been shown in patients on long term treatment with insulin[29]. The cause of this hypomagnesemia is not known for certain but the following have been suggested as possible mechanisms: a. increased loss of magnesium in urine due to the osmotic action of glycosuria; and b. depression of the net tubular reabsorption of magnesium due to hyperglycemia[29].

Magnesium may also play a role in the release of insulin[30]. Magnesium depletion has an atherogenic potential[31,32]. Hypomagnesemia has been postulated as a possible risk factor in the development and progression of diabetic retinopathy[28,33]. Future research is called for to see if repletion of magnesium retards the progression of retinopathy. Patients with myocardial infarction had reversal of abnormal lipoprotein patterns to normal on administration of magnesium[30,34]. The Bantus have lower prevalence of I.H.D. and higher serum magnesium levels than the Europeans[35]. Thus, magnesium may well have a local protective effect on the vessel well.

Conclusion:

These findings suggest that the diabetic type 2 patients have higher serum calcium levels, and lower magnesium levels compared to healthy individuals, while serum phosphate level was not affected.

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