Original article:

Serum and urinary calcium levels in Type 2 diabetes mellitus

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Abstract

Type 2 Diabetes mellitus (T2DM) is a common endocrine disorder. Apart from glucose, many other parameters are altered in this disease. Calcium has an important part in the bone metabolism, muscle and nerve function and various other roles. Data with regard to calcium in T2DM from the Indian subcontinent is sparse. So, the study was undertaken to evaluate the status of calcium in T2DM. Serum and urinary calcium levels were assayed in 108 subjects, including 51 T2DM patients and 57 controls. Serum calcium was significantly decreased and urinary calcium excretion was found to be increased in patients compared to controls. Calcium levels in body should be monitored to maintain homeostasis in T2DM.

Introduction

Increasing prevalence of T2DM in the world has made it one of the most important problems of the present day. As the number of diabetics in India is very high, the magnitude of the disease cannot be undermined. Mortality and morbidity from T2DM is huge and poses a large burden on our economy.

Though hyperglycemia and insulin resistance are hallmarks of T2DM, metabolism of various other parameters is also altered. Calcium is best known for its role in bone metabolism, but it has equally important nonskeletal functions like neuromuscular, cell signalling, etc (1). Insulin secretion is a calcium-dependent process; therefore, alterations in calcium metabolism and transport can have deleterious effects on beta-cell insulin secretion (2). Calcium is essential for intracellular processes, mediated by insulin, in insulin-responsive tissues like skeletal muscle and adipose tissue (3). Changes in calcium levels in primary insulin target tissues may lead to peripheral insulin resistance via impaired insulin signal transduction (4). Like many other parameters in T2DM, calcium may also have variations in its serum and urinary levels. We have not found any data with respect to serum and urinary calcium levels in T2DM in India. Thus, the purpose of our study was to evaluate the calcium levels in T2DM, as this might help in a better understanding of the pathophysiology and can aid in the management of T2DM.

Materials and methods

This case control study was conducted in the Biochemistry department of a tertiary care hospital, with subjects selected from the OPD patients randomly. The study protocol was approved by the Institutional ethics committee of the institute. T2DM patients, and healthy age and sex-matched patients' relatives attending the OPD were enrolled. 122 patients were initially enrolled for the study, but 10 patients and 4 controls dropped out later, so that ultimately 51 patients and 57 controls remained. Detailed medical history and relevant clinical examination was done; written consent was obtained from all subjects after the study procedure was explained. Fasting blood samples (5 ml fresh blood) were drawn and collected in new, disposable plastic tubes under aseptic conditions for the estimation of

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serum calcium. 24-hour urine was collected to estimate urinary calcium. Assay of all the parameters were carried out in fully automated analyzer by OCPC method (5).

Statistical analysis:

The results obtained were statistically analysed by SPSS software using student's t-test.

Results

Table 1 shows the levels of serum (in mg/dl) and urine calcium (in mg/24 hours) in patients and controls as Mean ± S.D.

Group	serum calcium	urine calcium
Patient (n=51)	8.6 ± 0.9	276 ± 21.3
Control (n=57)	9.3 ± 1.2	253 ± 17.8

Statistical analysis of serum calcium levels in patients and controls:

Unpaired t test results-

p value and statistical significance:

The two-tailed p value equals 0.0010

By conventional criteria, this difference is considered to be extremely statistically significant.

Confidence interval:

The mean of Group One minus Group Two equals -0.700

95% confidence interval of this difference: From -1.109 to -0.291

Intermediate values used in calculations:

t = 3.3972

df = 106

standard error of difference = 0.206

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Statistical analysis of urine calcium levels in patients and controls:

Unpaired t test results-

p value and statistical significance:

The two-tailed p value is less than 0.0001

By conventional criteria, this difference is considered to be extremely statistically significant.

Confidence interval:

The mean of Group One minus Group Two equals 23.000

95% confidence interval of this difference: From 15.537 to 30.463

Intermediate values used in calculations:

t = 6.1102

df = 106

standard error of difference = 3.764

Serum calcium was highly significantly decreased and urinary calcium excretion was found to be highly significantly increased in patients compared to controls.

Discussion

Insulin and its action is very much dependant on calcium, as is evident by the following facts - changes in calcium in primary insulin target tissues causes variations in insulin action (6) and decrease in insulin receptor phosphorylation, which is a calcium-dependent process (7). Changes in calcium alter adipocyte metabolism, which may lead to triglyceride accumulation via increased de novo lipogenesis and lack of suppression of insulin-mediated lipolysis (8). Changes in calcium levels in primary insulin target tissues leads to variations in insulin action (9). Patients with type 2 DM show decreased cellular calcium homeostasis in skeletal muscle, adipocytes, and liver cells (10,11). As because many diabetics show marked osteoporosis, periods of negative nitrogen balance and acidosis may be pathogenic factors for decrease of serum calcium (12). Calcium may be reduced in serum in T2DM due to less absorption of calcium (13, 14), or decreased levels of vitamin D (15,16). In our study decreased calcium levels were observed in patients, compared to controls (table 1).

Urinary calcium excretion is increased probably due to increased parathyroid stimulation (17,18,19) . Hypercalciuria of uncontrolled diabetes may be a form of renal hypercalciuria which could result in parathyroid stimulation, which in turn, might contribute to the development of osteopenia in patients with diabetes mellitus (17). Hypercalciuria may also be due to hypoparathyroidism in T2DM (20). Our study also observed increased urinary calcium excretion in patients, compared to controls (table 1).

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All these findings and evidence point to an imbalance of calcium metabolism in T2DM. Further research in this area, with particular reference to additional assay of vitamin D, parathormone, phosphate and other parameters should gain an insight in this regard.

Conclusion:

To conclude, hypocalcemia, together with hypercalciuria, occur in T2DM, and the alteration of calcium homeostasis might have implications in the pathophysiology as well as management of T2DM.

References

1. Calcium antagonism and calcium entry blockade. Godfraind T, Miller R, Wibo M. Pharmacological Reviews 1986, 38 (4); 321-416

2. Requirement for calcium ion in insulin secretion by the perfused rat pancreas. Curry DL, Bennett LL, Grodsky GM. Am Jr Physiol 1968, Vol 214,Issue 1, pp 174-178

3. Direct addition of insulin inhibits a high affinity Ca^{2+}-ATPase in isolated adipocyte plasma membranes. Pershadsingh HA, McDonald JM. Nature 1979, vol 281, p p 495–497

4. The existence of an optimal range of cytosolic free calcium for insulin-stimulated glucose transport in rat adipocytes. Draznin B, Sussman K, Kao M, Lewis D, Sherman N. J Biol Chem 1987,262:14385–14388

5. The colorimetricestimation of calcium in serum with o-cresolphthalein complexone. SternJ, Lewis WHP. Clin Chizn Acta 1957; 2:576-80.

6. Relationship between cytosolic free calcium concentration and 2-deoxyglucose uptake in adipocytes isolated from 2- and 12-month-old rats. Draznin B, Sussman KE, Kao M, Sherman N . Endocrinology 1988, 122:2578–2583

7. Calcium-dependence of insulin receptor phosphorylation. Plehwe WE, Williams PF, Caterson ID, Harrison LC, Turtle JR. Biochem J 1983, 214:361–366

8. PTH excess may promote weight gain by impeding catecholamine-induced lipolysis-implications for the impact of calcium, vitamin D, and alcohol on body weight. McCarty MF, Thomas CA. Med Hypotheses 2003, 61:535–542

9. Nutritional and endocrine modulation of intracellular calcium:
implications in obesity, insulin resistance and hypertension. Zemel MB. Mol Cell
Biochem 1998, 188:129–136

10. Calcium Homeostasis in Diabetes Mellitus. Heath H, Lambert PW, et al. Jr Clin Endocrinol Met 1979, Vol 49, Issue 3, pp 462–466

11. Calcium homeostasis in chronic streptozotocin-induced diabetes mellitus in the rat. Hough S, Russell JE, Teitelbaum SL, Avioli LV. Am Jr Physiol 1982, Vol 242 Issue 6, pp E451-E456

12. Serum potassium, magnesium, and calcium levels in diabetic acidosis. Martin HE, Wertman M. Jr Clin Invest 1947 , 217-228

13. Diabetes and intestinal calcium absorption in the rat. Schneider LE, Schedl HP. Am Jr Physiol 1972,Vol 223, Issue 6, 1319-1323

14. Significant Vitamin D Deficiency in Youth with Type 1 Diabetes Mellitus. Svoren BM, Volkening LK, Wood JR, Laffel LMB. Jr Pediatr
2009 Vol 154, Issue 1, pp 132–134

15. Concentrations of Serum Vitamin D and the Metabolic Syndrome Among U.S. Adults. Ford ES, Ajani UA, McGuire LC, Liu S. Diabetes Care 2005; 28(5): 1228-1230

16. The prevalence of vitamin D abnormalities in South Asians with type 2 diabetes mellitus in the UK. Tahrani AA, Ball A, Shepherd L , et al. IJCP 2010, Vol 64, Issue 3,2010 pp 351-355

17. The hypercalciuria of diabetes mellitus: its amelioration with insulin. Raskin P, Stevenson MRM, Barilla D, Pak CYC. Clin Endocrinol 1978, Vol 9, Issue 4 ,pp 329-335

18. The effect of streptozotocin-induced chronic diabetes mellitus on bone and mineral homeostasis in the rat. Shires R , Teitelbaum SL , Bergfeld MA , Fallon MD , Slatopolsky E , Avioli LV. Jr Lab Clin Med 1981, 97(2):231-240]

19. Hypercalciuria, Hyperphosphaturia, and Growth Retardation in Children With Diabetes Mellitus. Malone JI, Lowitt S, Duncan JA,et al. Pediatrics 1986, Vol 78, Issue 2

20. Hypoparathyroidism in diabetes mellitus. McNair P , Christensen MS, Madsbad S, Christiansen C, Transbøl I. Acta Endocrinol 1981 ,96; 81-86

21. Bone mineral metabolism in human type 1 (insulin dependent) diabetes mellitus. McNair P. Dan Med Bull 1988,35(2):109-121