Original article:

Study of serum zinc in diabetes mellitus

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Abstract:

Introduction: Certain trace elements like Zinc are essential for the normal metabolism of proteins, fats & carbohydrates. Chronic degenerative disorders like Diabetes mellitus (DM) are associated with tissue deficiency of one or more trace elements. The abnormal zinc metabolism may play a role in the pathogenesis of DM & some of its complications. The present study was intended with the objectives of study of serum zinc level in DM & its relation with it.

Methods: In the present study 30 known diabetic patients of age group 15-65 yrs were taken as study group with inclusion & exclusion criteria & were compared with the healthy control of same age group. The serum zinc levels of both the groups were estimated on G.B.C.932 model atomic absorption spectrophotometer. The data was analyzed by student unpaired t-test.

Results: The serum zinc level in study group (DM patients) was significantly low as compared to controls.

Conclusion: The decreased serum zinc level in diabetic patients may be attributed to poor reabsorption of zinc & also due to excessive excretion of zinc (zincuria) in diabetic patients. Further from our study it can be suggested that oral zinc administration in the diabetic patients may be helpful in wound healing & in the prognosis of the complications of Diabetes mellitus.

Key words: Serum zinc, Diabetes mellitus

INTRODUCTION

Certain trace elements are essential for the normal metabolism of proteins, carbohydrates and lipids. It has been known that certain chronic degenerative diseases occur as a result of tissue deficiency of one or another trace element. One such element is Zinc, which has gained a lot of importance especially in cases of Diabetes mellitus (DM). The essentiality of zinc for the growth of micro-organisms was first recognised by Raulin [1] in 1869. Zinc is one of the essential trace elements in man. It is involved in nearly all aspects of cellular metabolism and is essential for cell division and DNA synthesis [2]. Availability of zinc regulates the rate of synthesis of nucleic acids and proteins suggesting that its availability may critically influence tissue reparative processes [3].

Zinc is an essential trace metal directly involved in the physiology of Insulin [4]. It has been suggested that abnormal zinc metabolism may play a role in the pathogenesis of diabetes mellitus and some of its complications. The most interesting correlation between zinc and diabetes mellitus is the proven susceptibility of diabetics to infection and the role of zinc in the immune mechanism especially cell mediated immunity [5, 6]. Altered immune mechanism function is known to occur in diabetics who could be due to impaired metabolism of T-lymphocyte for which zinc is required. The same reason could hold true for zinc deficiency causing impaired wound healing in diabetics.

Atomic absorption spectrophotometry has proved itself to be the powerful instrumental technique for the quantitative determination of trace elements in liquids. The absorption of energy

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by ground state atoms in the gaseous state forms the basis of AAS [7, 8, 9].The present study was undertaken to evaluate serum zinc levels in Diabetes mellitus and to correlate it with age, sex, type of DM, duration of DM; complications of DM mainly impaired wound healing.

MATERIALS & METHODS

In the present study, 60 subjects (both males and females) were studied and they were divided in 2 groups, Healthy Control (30) and Diabetes mellitus (30) group. The study was conducted at Sir J. J. Group of Hospitals, Mumbai. Thirty normal healthy hospital staff personnel with no history of any medical illness were included in this group as control. Thirty ambulatory diabetic mellitus patients, both male and female attending diabetic clinic in J. J. Hospital, Mumbai with moderate or poor control of diabetes, with wound infections, especially feet ulceration were included in this study. They were in the age group of 15 yrs to 65 yrs. The duration of diabetes was from 1 month to 15 yrs. Patients on supplemental zinc and having Ischemic heart disease, Chronic alcoholism, h/o of pancreatitis were excluded from the study. Detailed history, clinical examination was done in all the subjects. Serum zinc level and fasting blood sugar were estimated in all the groups. The individuals were given explanation about the relevance of the study and the procedures. The participants gave informed written consent to participate in the experiment which was approved by human research ethics committee of the institute.

Collection of blood sample

Taking usual aseptic precautions, 3 ml of fasting blood sample was collected from antecubital vein into plastic test tubes for zinc estimation. The sample was centrifuged at 3000 rpm for 15 minutes. The supernatant serum (about 1 ml) was taken and delivered into plastic tubes with screw caps. The serum thus collected from all the groups was subjected for estimation of zinc on the same day.

Preparation of sample for estimation of serum zinc level

The serum prepared by above method was processed in the following way.

1) 1 ml serum   +   Add 5 ml of   ⟶   boil the sample till
   in Corning's beaker   conc. Nitric acid   Evaporation
                        (This step is repeated 3 times)

2) Sample   +   Add 2 ml of perchloric acid   ⟶   boil the sample till
                                                                Evaporation

3) Sample   +   Add 25 ml of dil. Nitric acid   ⟶   boil the sample to reduce
                    (2 M HNO_3)   volume for 10-15 minutes

4) Sample   +   Add distilled water   ⟶   Sample ready for analysis by AAS
                    To make the volume 25 ml

In our study, the analysis was performed with G. B. C. 932 model atomic absorption spectrophotometer at B.A.R.C Institute of Science, Colaba, Mumbai and the instrument was used in accordance with the manufacturers operating manual.The zinc level was determined by

comparing the signal from diluted serum with the signal from aqueous standards. First the zinc standard solutions were aspirated sequentially from most dilute to most concentrate. Then the diluted specimen serum samples were aspirated into the atomic absorption flame and analyzed and their absorbance's recorded. The resulting values were used to establish the working curve. A graph of Absorbance Vs Concentration is plotted. Concentrations of zinc in specimen samples were derived from comparison of sample absorption with the standard zinc curve. The results were expressed in micrograms per 100 ml (mcg/dl).

Statistical analysis: After the data was obtained and tabulated it was subjected to statistical analysis using student's unpaired' t' test and the significance of values obtained was found by determining 'p' value. The 'p' value obtained was in comparison with the control group. The results obtained on analysis were presented as Mean ± Standard Deviation for each of the parameters.

RESULTS:

In the present study, total 60 subjects both male and female were studied. They were divided into following groups.

Table 1: Showing distribution of study groups subjects and their serum zinc levels

Sr. No.	Group	No. of cases (n)	Male	Female	serum zinc levels (In mcg/dl)		
					Range	Mean± S.D.	Std. Error
1.	Group A-Control	30	20	10	104 to 130	114.46 ± 7.632	1.39
2.	Group B – Diabetes mellitus	30	17	13	56 to 130	78.33 ± 19.34	3.53

Group A: Serum zinc was estimated in 30 apparently healthy volunteers consisting of 20 males and 10 females with an age range from 25 yrs to 48 yrs (mean age was 37.2 ± 12.4 yrs). It is evident from the above table that serum zinc level in normal subjects was ranging from 104 to 130 mcg/dl with a mean value of 114.46 mcg/dl.

Group B: Serum zinc was estimated in 30 diabetic patients consisting of 17 males and 13 females with an age range from 15 yrs. to 65 yrs. (mean age was 45.2 yrs.). The serum zinc level in diabetic subjects was ranging from 56 to 130 mcg/dl with a mean of 78.33.

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Table 2: Showing means ± S. D. of age of diabetics and serum zinc levels

Sr. No.	Age range (In yrs.)	No. of cases	Serum zinc levels (mcg/dl)		t	p
			Range	Mean ± S. D.		
1.	15 to 65	30	56 to 130	78.33 ± 19.34	8.30	0.50 *N.S.

* N. S. - Not significant

The above table shows that the age of diabetics and serum zinc level does not show statistically significant difference.

Table 3: Showing means ± S. D. of sex of diabetics and serum zinc levels

Sr. No.	Sex of diabetics	No. of cases	Serum zinc levels (mcg/dl)		t	p
			Range	Mean ± S. D.		
1.	Male	17	56 - 122	78.35 ± 19.24	0.995	0.73 *N.S.
2.	Female	13	60 - 130	78.30 ± 20.31		

* N. S. - Not significant

The above table shows that the sex of diabetics and serum zinc level does not show statistically significant difference.

Table 4: Showing means ± S. D. of type of DM and serum zinc levels

Sr. No.	Type of diabetes	No. of cases	Serum zinc levels (mcg/dl)		t	p
			Range	Mean ± S. D.		
1.	IDDM	15	56-100	74.76 ± 15.56	0.200	0.58 *N.S.
2.	NIDDM	15	60 - 130	83.46 ± 21.92		

* N. S. - Not significant

The above table shows that the type of DM and serum zinc level does not show statistically significant difference.

Table 5: Showing correlation of duration of diabetes and serum zinc level

Sr. No.	Mean duration of diabetes	Mean serum zinc in diabetes	Correlation coefficient	Significance
1.	6.43 yrs.	78.33 yrs.	-0.416	0.22 *S

* S – Significant

The above table shows that there is an inverse correlationship between serum zinc level and duration of diabetes.

Table 6: Showing mean ± S. D. of complications of DM and serum zinc level

Sr. No.	DM with Complication/ No complication	No. of cases	Serum zinc levels (mcg/dl)		t	p
			Range	Mean ± S. D.		
1.	With Complication	18	56 - 100	70.44 ± 12.90	0.004	0.068 *S
2.	No complication	12	66 - 130	90.17 ± 21.81		

*S – Significant

The above table shows that the complications of the DM and the serum zinc level show statistically significant difference.

Table 7: Showing mean ± S.D. of serum zinc levels of control and DM group

Sr. No.	Serum zinc in control and DM	No. of cases	Serum zinc levels (mcg/dl)		t	p
			Range	Mean ± S. D.		
1.	Zinc in control	30	104 - 130	114.46 ± 7.63	10.21	0.000
2.	Zinc in DM	30	56 - 130	78.33 ± 19.34		*S

*S – Significant

The above table shows that serum zinc level in control and DM group show statistically significant difference.

DISCUSSION

The present study was carried out to evaluate the role of serum zinc in diabetes mellitus.

I. Serum zinc in control group:

In this study, serum zinc was estimated in 30 healthy individuals. The serum zinc level in control group was ranging from 104-130 mcg/dl (mean value of 114.46 mcg/dl). These values are comparable with studies done by various workers viz. Prasad et al. [8], Poggine et al [9], Davies et al [10], Rosner et al [11], Halstead et al [12], Harrison's [13], Khandelwal et al [14], Mani Uliyar et al [15]. The average serum zinc in our study in normal individuals was a little higher than reported by McBean et al (1974), Falchuk et al (1977) and Mishra et al (1979). Pidduck et al [16], Macklay et al [7] suggested the difference in the values of normal serum zinc may be due to different geographical and environmental factors, dietary intake and different methods of estimation used.

II. Serum zinc in Diabetes mellitus:

In the present study, certain observations were made regarding the correlation of serum zinc levels in diabetic subjects with different parameters such as age and sex of diabetics, type of diabetes, duration of diabetes, complications of diabetes; and with that of normal healthy controls.

Serum zinc and age and sex of diabetics:

The wide range of serum zinc level in different age groups (from 15 yrs to 65 yrs) was from 56 to 130 mcg/dl (mean 78.33). In 17 male diabetics, serum zinc level was ranging from 56 to 122 mcg/dl (mean 78.30) where as in 13 female diabetics; serum zinc level was ranging from 60 to 130 mcg/dl (mean 78.35). We have found no evidence that age and sex of diabetic subjects affect the serum zinc level. These findings in this study correlate with Davies et al [10], Pidduck et al [16] and Khandelwal et al [14].

Serum zinc and type of diabetes mellitus:

Serum zinc was determined in 15 cases of Insulin Dependent Diabetes Mellitus (IDDM) and equal number of Non-Insulin Dependent Diabetes Mellitus (NIDDM). The serum zinc level in IDDM was ranging from 56 to 100 mcg/dl (mean 74.76). Whereas in NIDDM from 60 to 130 mcg/dl (mean value of 83.46 mcg/dl). The results indicated that the serum zinc levels were low in cases of IDDM and NIDDM as compared to normal healthy controls, but there was no statistically significant difference between the type of diabetes mellitus and serum zinc level. Our findings regarding the type of diabetes mellitus with serum zinc level are supported by Niewoehner et al [17]. In the study by Mani Uliyar [15], statistically significant low values of serum zinc was obtained in IDDM subjects as compared to NIDDM and normal subjects.

Serum zinc and duration of diabetes mellitus:

In so far as the relation between serum zinc level and the duration of diabetes mellitus is concerned, significant low serum zinc (mean 73.23) was

observed in diabetics of longer duration (more than 5 yrs) than in those patients where duration was less than 5 yrs (mean 82.23). This study has also found the inverse correlation ship between duration of diabetes mellitus and serum zinc level indicating that when duration of diabetes mellitus increases, serum zinc level goes down. This finding seems to correlate with those of Khandelwal et al [14]. Earlier no correlation with the duration of diabetes mellitus and serum zinc was observed in a study by Pidduck et al [16].

Serum zinc and complications of diabetes mellitus:

In 18 diabetic patients who presented with complications namely impaired wound healing, had mean serum zinc 70.44 mcg/dl and in 12 diabetic subjects without any complication the mean serum zinc level was 90.17 mcg/dl. Diabetic patients with complications had statistically significant low serum zinc as compared to those who did not. This finding is supported by work of Khandelwal et al [14]. A study by Poggine et al [9] on wound healing in a group of military hospital patients showed that the oral administration of zinc sulphate had an accelerating effect on healing process. Probably zinc has a vital role to play in immunity and wound healing. Zinc may regulate collagen deposition.

Serum zinc in diabetes mellitus and control subjects:

In this study, serum zinc level in normal healthy individuals was ranging from 104 to130 mcg/dl (mean 114.46) whereas in diabetic subjects, it was ranging from 56 to 130 mcg/dl (mean 78.33). We are observed statistically significant low serum zinc in diabetic subjects as compared to control subjects. Our findings are in accordance with previous study by Khandelwal et al [14], whereas others like Rosner et al [11], Pidduck et al [16] observed no significant difference in normal healthy individuals and

diabetics. In contrast to our results, few other studies by Davies et al [10], Buckowaski et al [18] found high serum zinc in diabetics as compared to normal subjects which was statistically not significant. Whereas Constam et al found plasma zinc to be significantly low in diabetes mellitus. There is a yet unexplained disorder of zinc metabolism, demonstrated by significant hyperz- incuria (Pidduck et al [16] and Constam et al, 1964). Abnormal zinc metabolism could play a role in the pathogenesis of diabetes mellitus and some of its complications. Pidduck et al [16] demonstrated highly significant differences in the urinary zinc excretion between diabetic and control group. It could be that the hyperzincuria in the diabetic indicates an abnormality of production or breakdown of zinc metalloenzyme or zinc-enzyme complex. Zinc depletion is likely to be present in the diabetics due to excessive urinary losses uncompensated by increased gastro-intestinal absorption (Kinlaw et al [19]).

CONCLUSION

From our study it can be suggested that oral zinc administration in the diabetic patients may be helpful in wound healing & in the prognosis of the complications of Diabetes mellitus.

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