Research Article

ZINC LEVEL IN BLOOD SERUM AND EFFECT OF ITS DECREASED CONCENTRATION IN CHRONIC RENAL FAILURE PATIENTS

*Punam Yadav
Department of Chemistry, M. S. College, Saharanpur U.P.
*Author for Correspondence

ABSTRACT

It has been observed that there are at least 29 different types of elements in our body. Organic compounds such as carbohydrates, proteins and lipids form about 90% of the solid matter and mainly consist of C, H, O and N. Chronic renal failure affects metabolism of trace elements like any other infectious disease. Zinc is an important trace element in the body and it has been recognized as a constituent of prime importance in a variety of metallo-enzyme systems, biochemical pathways essential for protein synthesis and metabolism of carbohydrates, fats and proteins. Zinc is therefore, crucial for growth and development. More recently DNA dependent, RNA polymerase has been shown to be zinc dependent enzymes. The total content of zinc in man has been estimated to vary from 1.4 to 2.4 gms. The major portion of this is present in muscles tissues which have about 63% of total zinc content. The daily requirement depends upon age, weight, rate of growth, functional activity or environmental temperature. In chronic renal failure patients the concentration of zinc in plasma decreases. The hypozincaemia in uremia is rather a result of shift of zinc from plasma into tissues than a manifestation of zinc deficiency. The present study includes the study of serum zinc levels of 200 patients (according to age group and sex) with chronic renal failure (CRF) before and after the process of treatment and it has been compared with 50 normal healthy individuals comprising the control group.

Keywords: Chronic Renal Failure, Hypozincaemia, Serum Zinc, Biochemical Studies, Uremia

INTRODUCTION

Zinc is an important cation in the body. It has been over 100 years since the role of zinc is demonstrated as an essential nutrient for the growth of "Aspergillus Niger". Conclusive evidence of the essentiality of zinc to the normal growth and development of animals was not reported until 1934 (Tood *et al.,* 1934). The first concrete demonstration of a specific biologic function was published in 1939 (Kellin and Mann, 1939). Expect for iron, the amount of zinc required in diets and found in tissue is substantially greater than those for any other trace element. In recent times, zinc has been recognized as a constituent of prime importance in a variety of metallo-enzyme systems and biochemical pathways essential for protein synthesis and metabolism of carbohydrates, fats and proteins. Zinc is therefore, crucial for growth and development. More recently DNA department, RNA polymerase has been shown to be zinc dependent enzymes (Kirchgessner *et al.,* 1976) and the activity of ribonuclease has been demonstrated to increase in zinc deficient tissue, suggesting that RNA catabolism is regulated by zinc (Prasad *et al.,* 1976, 1977 & 1978). Shaughnessy *et al.,* (2005) suggested that renal suffer from more diseases such as Glomerular disease, Tubular disease, Urinary tract infection, Urinary tract obstruction, Renal calculi, Cystic disease, Vascular disease, Tumors and Renal Failure. In Britain, approximately 55 new patients per million of the adult population progress to terminal renal failure each year (Davidson's XV edition). Renal system is one of the major systems of human body beside cardiovascular, pulmonary, hepatic and central nervous system. Kidney is the main organ of renal system. It contains nephrons which are the main unit of kidney. In modern world of changes and challenges, morbidity and mortality renal failure has become a serious cause of concern. Chronic Renal Failure (CRF) is a disease of insidious onset and progressive course with gradual deterioration of renal function and of such severity that the kidneys are no longer be able to keep the internal environment normal. Swelling in the hands, face or feet, Nausea or vomiting, Loss of appetite, Changes in urination, Itching of the skin, Headache and confusion, Fatigue and weakness etc are the signs which have been observed by Fiaccadori *et al.,* (2001). End-Stage Renal Disease (ESRD) is the

Research Article

final stage of CRF which is a progressive, irreversible deterioration in renal function in which the body ability to maintain fluid and electrolyte balance fails. Chronic renal failure can lead to multiple medical and physical problems require physical therapy treatment. The purpose of this paper is to provide an understanding of the medical treatment and the complications of chronic renal failure. The physical therapy management of the patient on dialysis and that of the patient with a kidney transplant differs as to the extent and aggressiveness of the program. Providing the proper physical therapy program for patients with chronic renal failure is often a challenge because of such complications as congestive heart failure and peripheral neuropathies studied by Paula *et al.,* (1982). Stevons *et al.,* (1970) reported approximately 50 persons per million populations suffer from chronic renal failure. Severity of renal failure is common feature now a day in India. It is conceivable that the figures would be comparable to those reported from the west. This would mean an incredible figure of 30,000 persons with chronic renal failure every year in India alone. Keeping in view the above mentioned facts, the present paper is planned to evaluate the serum zinc level in the management of chronic renal failure patients and also to study the prognostic significance of these parameters. Stenvinkel *et al.,* (2002) reported that chronic renal failure (CRF) is one of the most severe diseases worldwide. Lise *et al.,* (2009) studied that renal failure occurs when the kidneys cannot properly remove wastes that causes buildup of waste and fluid in the body.

Experimental

MATERIALS AND METHODS
The present study was carried out on 200 adult patients of chronic renal failure attended in the S.V.B.P. hospital attached to L.L.R.M. Medical College, Meerut and also 50 normal healthy individuals with age, sex matched who had no history of renal failure to serve as controls. All the known cases of chronic renal failure were included in this study on the basis of clinical and biochemical criteria. A known case of renal failure for more than three months duration (Harrison XIII edition. Page 1284) and persons having blood urea more than 50 mg% were chosen for study. After confirmation of diagnosis on the above parameters, blood samples were drawn from these patients for the estimation of serum urea. All the chemicals and reagents used were of analytical grade: otherwise they were purified before use.

RESULTS AND DISCUSSION
Observations

Table I: Showing distribution of C.R.F. cases according to age group and sex

Age Groups (Years)	Number of cases		Total
	Males	**Females**	
10-30	5	2	7(3.5%)
31-50	50	25	75(37.5%)
51-70	63	40	103(51.5%)
71-above	10	5	15(7.5%)
Total	**128(64.0%)**	**72(36.0%)**	**200(100.0%)**

Table II: Showing distribution of control cases according to age group and sex

Age Groups (Years)	Number of cases		Total
	Males	**Females**	
10-30	4	1	5(10.0%)
31-50	12	6	18(36.0%)
51-70	18	9	27(54.0%)
Total	**34**	**16**	**50(100.0%)**

Out of 200 individuals, 128 (64%) controls were male's individuals and rest 72 (36%) were females. The maximum number of cases, 103 (51.5%), were observed in the age group of 51-70 years followed by 75

Research Article

(37.5%) cases in the age group of 31-50 years, 15(7.5%) cases in the age group of above 70 years and 7 (3.5%) cases in the age group of 10-30 years.

Out of 50 control cases, 34 (68.0%) cases were males and 16 (32.0%) were females. 54.0% were found in the age group 51-70 years, 36.0% were 31-50 years age group and 10.0% were 10-30 years age group.

Table III: Distribution of C.R.F. cases according to duration of illness

Duration of illness	No. of cases	Percentage %
3 months-6 months	42	21.0%
6 months-1 year	114	57.0%
More than 1 year	44	22.0%
Total	**200**	**100.0%**

The majority of chronic renal failure cases were among more than 6 months- 1 year duration (114 cases, 57.0%) and then more than I year children (44 cases, 22.0%).

Table IV: Serum zinc levels in normal healthy control

Age in yrars	Male			Female			Total		
	No.	Range (µg/100 ml)	Mean=S.D.	No.	Range (µg/100 ml)	Mean=S.D.	No.	Range (µg/100 ml)	Mean=S.D.
10-30	4	76-115	103.75±16.08	1	73-80	73.00±9.32	5	73-115	97.60±18.92
31-50	12	80-114	98.38±28.86	6	85-110	97.58±8.46	18	80-114	98.11±9.49
51-70	18	83-115	97.61±9.26	9	80-109	97.33±9.44	27	80-115	97.52±9.29
Total	**34**	**76-115**	98.59±10.41	**16**	**73-110**	**95.88±10.84**	**50**	**73-115**	**97.72±10.79**

The level of serum zinc in healthy subjects was 73-115 µg/100ml (mean 97.72±10.79 µg/100ml). In males, the range was 76-115 µg/100ml (mean 98.59±10.41 µg/100ml) and in females, the range was 73-110 µg/100ml (mean 95.88±10.84 µg/100m)l. The highest serum zinc level was observed in the age group of 31-50 years, ranged as 80-114 µg/100ml (mean 98.11±9.49 µg/100ml) followed by the age group of 10-30 years, ranged as 73-115 µg/100ml (mean 97.80±18.92 µg/100ml) and the age group of 51-70 years, ranged as 80-115 µg/100ml (mean 97.52±9.29 µg/100ml) respectively. No significant difference was seen among the serum zinc levels of different age groups and sexes.

Table V: Serum zinc levels before and after treatment in total cases of chronic renal failure

Interval	No. of Cases	Serum Sodium Range (µg/100 ml)	Mean ± S.D.
Control	50	73-115	97.72±10.79
Before treatment	200	48-96	81.20±12.84[***]
15 days after treatment	186	50-100	85.60±13.77[***]
30 days after treatment	169	60-108	91.56±10.95[***]
60 days after treatment	145	66-110	95.36±8.74
90 days after treatment	122	70-114	97.04±10.34

P- Significance, control vs treatment
$*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

The range of serum zinc level was significantly low before and after thirty days of treatment in the patients of chronic renal failure as compared to controls. The range of serum zinc before and after fifteen and thirty days of treatment were 48-96 µg/100 ml (mean 81.20±12.84 µg/100 ml), 50-100 µg/100 ml (mean 85.60±13.77 µg/100 ml) and 60-108 µg/100 ml (mean 91.56±10.95 µg/100 ml) respectively.

Research Article

Serum zinc level after sixty and ninety days of the treatment ranged as 66-110 μg/100 ml (mean 95.36±8.74 μg/100 ml) and 70-114 μg/100 ml (mean 97.04±10.34 μg/100 ml) respectively. After sixty and ninety days no significant difference was observed in serum zinc as compared to controls.

Discussion

Chronic renal failure is the disease in which kidneys are no longer able to keep the internal environment normal. The alterations in biochemical and clinical signs and symptoms have become more and more questionable. In recent years with the advent of dialysis and renal transplantation, the profile of chronic renal failure has changed to a great extent. The longevity of patients of chronic renal failure has substantially increased with the treatment by dialysis and renal transplantation. The purpose of present study is to find out some biochemical procedure which may be helpful in making the diagnosis of chronic renal failure and monitoring the prognosis of disease and find out any biochemical abnormalities in the patients of chronic renal failure. The present study is conducted on a total of 250 individuals, out of which 50 are normal healthy individuals comprising the control group and rest 200 is of chronic renal failure.

Controls

All the 50 healthy controls were between the age group of 10-70 years. The majority being of the age group 51-70 years. Out of 50 healthy controls 34 (68%) controls were male individuals and rest 16 (32%) were females.
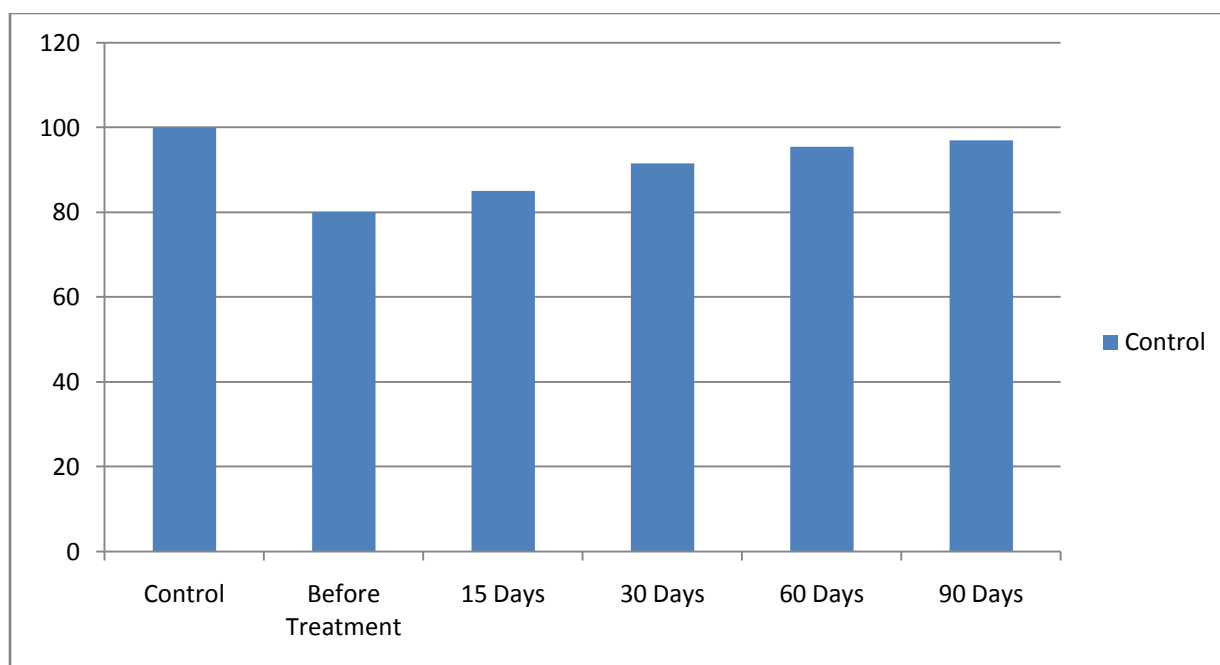

Figure 1: Serum zinc levels in total cases of chronic renal failure

In normal healthy subjects serum zinc ranged from 73-115 μg/100ml (mean 97.72±10.79 μg/100ml).In males, it ranged from 76-115 μg/100ml (mean 98.59±10.41 μg/100ml and in females, 73-110 μg/100ml (mean 95.88±10.84 μg/100ml. Highest serum zinc level was observed in the age group of 31-50 years (98.11±9.49 μg/100ml) followed by the age group of 10-30 years (97.60±18.92 μg/100ml) and the age group of 51-70 years (97.52±9.29 μg/100ml). No significant difference owing to age and sex was noted in this study. Similar results have been obtained by Koch *et al.,* (1957), Brieter *et al.,* (1978) and Gupta *et al.,* (1984). Mahajan *et al.,* (1985) observed serum zinc as 112±10.0 μg/100ml.

Biochemical Studies

The levels of serum zinc were studied in controls and in all cases of chronic renal failure. In normal healthy subjects serum zinc ranged from 73-115 μg/100ml (mean 97.72±10.79 μg/100ml).In males, it ranged from 76-115 μg/100ml (mean 98.59±10.41 μg/100ml) and in females, 73-110 μg/100ml (mean

Research Article

95.88±10.84 µg/100ml). No significant difference was observed in the serum zinc level of different age groups and sex. In cases of chronic renal failure serum zinc was found to be depressed in 72% cases and before treatment, the level was 81.20±12.84 µg/100 ml which was significantly low (p < 0.001) as compared to that of controls (97.72±10.79 µg/100 ml). Similar observations have been made by Condon *et al.,* and Freeman *et al.,* (1970), Alkin-Thor *et al.,* (1978), Gilli *et al.,* (1985), Killerech *et al.,* (1970) and Armstrong *et al.,* (1980) described normal, slightly less than normal and high level of serum zinc in chronic renal failure cases.

After 15 days of treatment, the level of serum zinc increased to 85.60±13.77 µg/100ml. This was significantly low (p < 0.001) as compared to controls (97.72±10.79 µg/100ml). Thirty days after treatment, the level of serum zinc increased to 91.56±10.95 µg/100ml which was significantly low (p < 0.001) as compared to controls. After 60 days of treatment, the level of serum zinc returned to normal in 112 cases and the level was 95.36±8.74 µg/100ml. Though the level increased but the difference was found to be insignificant as compared to controls. Ninety days after treatment, the level of serum zinc returned to normal in all cases of chronic renal failure. The level was 87.04±10.34 µg/100ml .In the present study, only 122 cases out of 200 cases turned up for follow-up to the last. This figure was low, because most of the cases defaulted in treatment. The cases showing normal level of serum zinc were also found to be clinically improved cases. The number of cases at different intervals gradually declined as some could not turn up for follow-up. Thus, the serial estimation of serum zinc level during follow-up is a useful tool for assessing the prognosis of the disease.

Conclusion

The present study was carried out on 200 patients of chronic renal failure, who came to the S.V.B.P. hospital attached to L.L.R.M. Medical College, Meerut. In this study 250 individuals were included. Out of these 200 patients were of chronic renal failure and 50 individuals were normal healthy controls.

The diagnosis of chronic renal failure was made on clinical, biochemical and radiological basis. 50 normal healthy individuals including 34 males and 18 females, between the ages of 10 to 70 years, were studied as controls.

Blood samples were collected and serum zinc was estimated before treatment and after the treatment on 15th, 30th, 60th and 90th day in chronic renal failure patients.

In chronic renal failure cases, hypozincaemia occurs. Before treatment the level ranged between 48-96 µg/100 ml and mean 81.20±12.84 µg/100 ml. After thirty days of treatment, levels of serum zinc remained increased. The levels of serum zinc after fifteen and thirty days of treatment ranged between 50-100 µg/100 ml and 60-108 µg/100 ml and mean 85.60±13.77 µg/100 ml and 91.56±10.95 µg/100 ml respectively which is significantly decreased.

After sixty and ninety days of treatment, the levels of serum zinc returned to normal ranging between 66-110 µg/100 ml and 70-114 µg/100 ml and mean 95.36±8.74 µg/100 ml and 97.04±10.34 µg/100 ml respectively. In normal healthy subjects, the levels of serum zinc were 73-115 µg/100ml and mean 97.72±10.79 µg/100ml. In the study group the levels of serum zinc were found significantly decreased, ranging between 48-96 µg/100ml and mean 81.20±12.84 µg/100ml. Highly significant difference (p< 0.001) was observed among the chronic renal failure patients and controls. Serum zinc levels are related to the extent of disease.

The following conclusions are derived from this study:

1- There was insignificant difference in the levels of all the above mentioned parameters asregards to age or sex of the healthy controls included in this study.

2- Maximum probabilities of chronic renal failure were found in the age group of 51-70 years (51.5%).

3- Minimum probabilities of chronic renal failure were found in the age group of 10-30 years (3.5%).

4- The levels of serum zinc were found to be significantly depressed in cases of chronic renal failure as compared to that of controls.

5- The levels of serum zinc remained low after thirty days of treatment and then returned to normal.

6- The fall in the levels of serum zinc is related to the extent of the disease.

7- The levels shifted to normal range as the condition of patients improved clinically.

Research Article

REFERENCES

Armstrong VW, Buschmann U, Ebert R, Fuchs C, Reger J and Scheler F (1980). Biochemical investigation of CAPO: Plasma levels of trace element and amino acid and impared glucose tolerance during the course of treatment. *International journal of Artificial Organs* **3** 237-241.

Atkin-Thor E, Goddard BW and O'Nion J (1978). Hypothesis and zinc depletion in chronic dialysis patients. *American Journal of Clinical Nutrition* **31** 1948-1951.

Brieter DN, Diasio RS, Neifield JP, Roush ML and Rosenberg SA (1978). Serum copper and zinc measurements in patients with osteogenic sarcoma. *Cancer* **42** 528.

Condon CJ and Freeman RM (1970). Zinc metabolism in renal failure. *Annals of Internal Medicine* **73** 531-536.

Fiaccadori E, Maggiore U, Clima B, Melfa L, Rotelli C and Borghetti A (2001). Incidence, risk factors, and prognosis of gastrointestinal hemorrhage complicating acute renal failure. *Kidney International* **59** 1510–9.

Gilli P, Fagioli F, Depaoli Vitali E and Farinelli A (1985). Is zinc creating problem in the dietary treatment of CRF. *Nephron*, **40** 382.

Gupta KC and Mehta MR (1984). Status of zinc in Pulmonary tuberculosis. *Journal of the Association of Physicians of India* **32**(5) 421-423.

Harrison (1992). *Principles of Medicine*, XIII edition.

John Macleod, Chirstopher Edwards and Ian Bouchier (1987). *Davidson's Principles and Practise of Medicine*, fifteenth edition.

Keilen D and Mann T (1939). Carbonic Anhydrase. *Nature* **144** 442-3.

Kichgesser H, Roth HP and Weigand E (1976). *Biochemical Changes in Zinc Deficiency in Trace Elements in Human Health and Disease,* edited by Prasad AS (Acad. Press) New York **I** 189.

Killerich S and Christiansen C (1986). Distribution of serum zinc between albumin and α-2-macroglobulin in patient with different zinc metabolic disorder. *Clinica Chemica Acta* **154** 1-6.

Koch HJ, Smith JR and McNaly J (1957). Analysis trace elements in human tissues; II, Lymphomatous diseases. *Cancer* **10** 151-160.

Lise M, Cassio L and Richar MG (2009). Kidney Failure. *The Journal of the American Medical Association* **301**(6) 686.

Mahajan SK, Gardiner AA and Abbasi AA (1978). Abnormal plasma and erythrocyte zinc distribution in uremia. *Transactions - American Society for Artificial Internal Organs* **24** 50-54.

Mahajan SK, Rue D, Sondheimer JH and McDonald FD (1985). Copper metabolism in uremia. Effect of dialysis and zinc supplementation. *Transactions - American Society for Artificial Internal Organs* **31** 521-525.

Mansouri K, Halsted JA and Gombos (1970). Zinc, Copper, Magnesium and Calcium in dialyzed and non dialyzed uremic patients. *Archives of Internal Medicine* **125** 88-93.

O'Nion J, Atkin-Thor E and Rothert SW (1978). Effect of zinc supplementation on red blood cell zinc, serum zinc taste acuity and dietary intake in zinc deficient dialysis patients. *Dialysis & Transplantation* **7** 1208-1213.

Paula J Gray (1982). Management of Patients with Chronic Renal Failure: Role of Physical Therapy. *Journal of the American Physical Therapy Association* **62** 173-176.

Prasad AS (1977). Zinc in human nutrition. *CRC Critical Reviews in Clinical Laboratory Sciences* **8** 1-80.

Prasad AS, Brewer G, Shoemaker E and Rabbani P (1978). Hypercupremia induced by zinc therapy in adults. *JAMA* **240** 2166.

Prasad AS, Ortega J and Brewer GJ (1976). Trace elements in sickle cell disease. *Journal of the American Medical Association* **235** 2396-2398.

Shaughnessy D (2005). *An Introduction to Haemodialysis*, 1st edition, Fresenius Medical Care 5-7.

Stenvinkel P and Alvestrand A (2002). Inflammation in end-stage renal disease: Sources, Consequences, and Therapy. *Seminars in Dialysis* **15**(5) 329-337.

Research Article

Stevans L (1970). A reginol project in haemodialysis and transplantation. *Archives of Surgery* (100) 506.
Tood WR, Elvehjem CA and Hart EB (1934). Nutrition classics; zinc in the nutrition of the rat. *American Journal of Physiology* **107** 146.