

Aluminum (Al^{+3}) Intoxication in Normal Humans

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ABSTRACT

Aluminum intoxication was studied in 40 normal healthy individuals. Blood urea and serum creatinine levels were tested in order to select the healthy individuals. It was found that 20% individuals had aluminum level in toxic range ($>100 \mu\text{g/L}$). Age wise comparison showed that age did not have effect on any of the parameter tested i.e. blood urea, serum creatinine and aluminum level. However, the high levels of Aluminum in 20% individuals is very alarming. Use of aluminum utensils and aluminum preparation to combat gastric acidity were found to be the major cause of the toxicity.

Key Words: Aluminum; Blood urea; Serum creatinine; Gastric acidity; CNS; Cholestosis

INTRODUCTION

Aluminum is considered as an important element especially in patients with chronic renal failure (Gluszek & Adamezak, 1993; Pflanz *et al.*, 1994). As phosphate binder (e.g. in the form of aluminum hydroxide) it is mainly used to reduce the level of phosphates in blood serum, if ingested through dietary sources, aluminum is absorbed from the intestine and is excreted mainly through the kidneys (Coburn & Robertson, 1989). Renal excretion increases many fold in the individuals exposed to high level of aluminum. The excretion is impaired in case of non-functioning kidneys e.g. in chronic renal failure (Coburn & Robertson, 1989). Retention of aluminum in body causes toxic effect on various biological system (Hathcock, 1982). Such as Al^{+3} inhibits para-thyroid secretion (Fernandez *et al.*, 1992); exposure to high level of aluminum (Al^{+3}) can effect the human central nervous system (Sjogren & Elinder, 1992); Al^{+3} accumulation in liver causes cholestosis (Klein *et al.*, 1993) limited Al^{+3} elimination also results in osteomalacia and microcytic anemia (Gluszek & Adamezak, 1993). Aluminum is extensively used in Pakistan as phosphate binder in the renal failure patients. A study was therefore, planned to find out the probable toxic level of Al^{+3} in patients having repeated hemodialysis (Ghori & Yaqub, 1999). During the course of study it was found surprisingly that some normal persons also had Al^{+3} level in the toxic range. The results for such an investigation are presented in the present paper. In countries like Pakistan, where aluminum utensils are widely used in kitchens and unbalanced diet in routine, incidence of aluminum intoxication is more than the western societies. The probable reasons for such aluminum toxicity are also

reported. It will be helpful for creating the awareness among peoples against aluminum toxicity.

MATERIALS AND METHODS

Forty normal healthy adults from 20 to 60 years of age were selected for the study. Medical history, general physical examination blood urea and serum creatinine levels were checked to declare the normal healthy individual.

Aluminum estimation. 3 ml blood was taken from antecubital vein, allowed to clot for 30 minutes and serum was collected by centrifuging at 400 rpm for 5 minutes. The serum samples were stored at -20°C till further analysis.

For digestion, 0.5 g serum sample was boiled to dense fumes in 5 ml conc. HCl, 5 ml conc. HNO_3 and 7 ml perchloric acid. the sample was reboiled after addition of 30 ml water, diluted to 100 ml and subjected to analysis and pH was adjusted to 2.5-3.0 with the help of 10% NaOH solution. Ten ml buffer complex solution [10 ml (thioglycollic acid) was added to 2.5% CaCO_3 solution (dissolved in dd H_2O with the help of concentrated HCl and CO_2 was removed through boiling for 1-2 minutes), diluted to 400 ml and pH was adjusted to 4.2. 14% glacial acetic acid and 14% sodium acetate (hydrated) to one litre] and 10 ml alizarin red S soln. (1%) was added to the digested solution, diluted to 100 ml, allowed to stand for 3 hours and absorbance was noted at 495 nm using spectrophotometer (Tietz, 1926).

Hematological parameters. Blood urea was determined by enzymatic colorimetric method with salicylate (Diagnostic kit of Boehringer Mannheim GmbH diagnostic; Fawcett & Scott, 1960).

Serum creatinine was measured by Jaffe's reaction without deproteinisation; kinetic method

(Diagnostic kit of E. Merck 64, 27, Darmstadt Germany Diagnostic-Merck; Helger *et al.*, 1974).

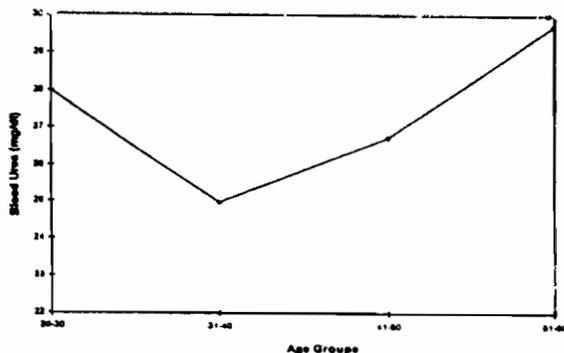
STATISTICAL ANALYSIS

The data obtained were subjected to relevant statistical analysis applying analysis of variance (Steel & Torrie, 1982).

RESULTS AND DISCUSSION

All the subjects were further classified in to four sub groups according to various age groups: 20 to 30, 31 to 40, 41 to 50 and 51 to 60 years of age. The highest mean value of blood urea i.e. 29.7 mg/dl was recorded for the age group 51-60 years where as, the minimum value i.e. 24.97 mg/dl was recorded in the age group 31-40 years. The respective values recorded in the age group 20-30 years and 41-50 years were 28 mg/dl and 26.75 mg/dl (Fig. 1). Regarding creatinine level the difference was found non significant when the subjects of different age group in different classes of normal individual were compared. Highest mean level (1.35 mg/dl) was recorded for the age group 20-30 years, whereby the minimum level (1.23 mg/dl) was detected in the age group of 41-50 years. Incidentally, the same value for serum creatinine (1.26 mg/dl) was observed in the both age groups of 31-40 and 51-60 years (Fig. 2).

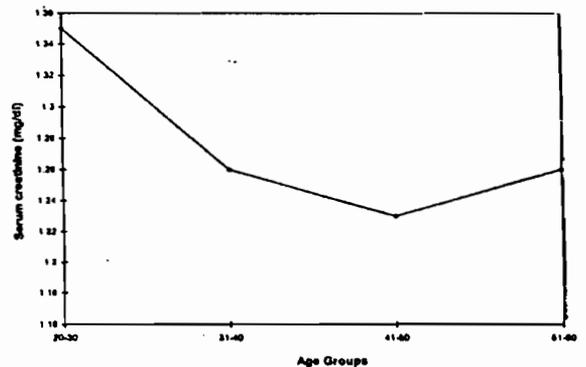
Fig. 1. Blood urea vs age groups



The highest aluminum level (92.33 $\mu\text{g/L}$) was detected in individual of age group 20-30 years followed by 76.89 $\mu\text{g/L}$, 72.08 and 69.66 $\mu\text{g/L}$ in age group 41 to 50 years, 51-60 years and 31 to 40 years respectively (Fig 3). Again age did not have any effect on aluminum retention. However, serum aluminum concentration ranged from 92.91 243.50 $\mu\text{g/L}$ (Table 1). Surprisingly 20% of the abnormal individuals were

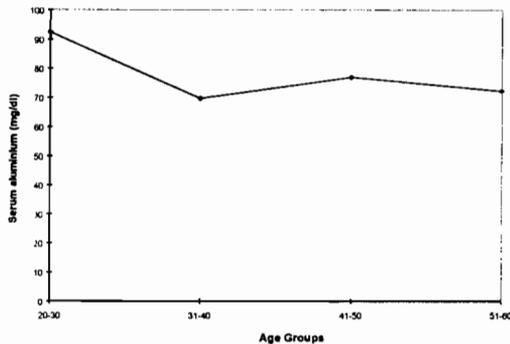
found to have serum aluminum level above the base line level i.e. (> 100 $\mu\text{g/L}$).

Fig. 2. Normal serum creatinine vs age groups



The investigatory studies revealed a number of plausible possibilities. For instance some of the individuals sampled for the study were found to have suffered from frequent complaint of gastric acidity and therefore were in practice of taking aluminum containing antacid oral preparation. An other contributory factor may be the frequent use of aluminum utensils for over year together because this social practice have also been reported to lead to aluminum exposure in human additional to the other sources.

An other speculation about the abnormally high level of aluminum found in sera of normal individuals may possibly be the administration of 1, 25 dihydroxycholecalciferol ($1,25(\text{OH})_2\text{D}_3$). As it has been found to increase serum aluminum level with a concomitant decrease in liver aluminum (Drueke *et al.*, 1985). The dietary aluminum intake in human being ranged from 18-36 mg/day. The authors suggested that dietary intake of the aluminum was enhanced by use of aluminum vessel for cooking. In relation to an other mode of aluminum exposure a part from ingestion, an inhalation exposure was reported by Sjogren and Elinder (1992). Over a period of four years of exposure to the welding fumes at an environmental concentration of approximately 1.6 mg m^{-3} of aluminum. This prolong exposure to aluminum was found to create accumulative toxicity in victims leading to CNS symptoms and abnormalities of psychomotor functioning. A greater likelihood of aluminum exposure to humans has been discussed by Modi (1961) who pointed out the frequent use of alum as a constituent of certain baking powder to whiten bread as well as for water purification purposes prior to filtration. The worker indicated the human intake of

Fig. 3. Normal serum aluminum vs age groups

aluminum through various vegetables, fruits, milk, egg and sea food. The worker also emphasized on hazardous slow poisoning of the workers in aluminum ware factories. The symptoms recorded in such workers were loss of memory, jerky movements, impaired coordination and urinary incontinence.

Table I. Serum aluminum levels ($\mu\text{g/L}$) in individuals having high aluminum values (three highest values for each age group are given)

Age group	Highest values	Serum Al ³⁺ $\mu\text{g/L}$
20-30	1	243.50
	2	144.18
	3	105.73
31-40	1	131.36
	2	126.55
	3	107.33
41-50	1	108.93
	2	99.32
	3	92.91
51-60	1	97.72
	2	83.30
	3	81.70

CONCLUSION

In Pakistan, use of aluminum utensils is still very common. It is concluded from the present studies that care should be taken in using such materials. Furthermore clinicians should use some alternative for aluminum or at least recommend very low dose of aluminum containing compound in their prescriptions.

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