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Original Research Article

# A Study of serum aluminium levels in patients of Chronic Renal Failure on haemodialysis

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**Abstract:** Chronic Kidney Disease (CKD) is a clinical condition in which there is an irreversible loss of endogenous renal function, to render the patient permanently dependent upon renal replacement therapy. Even optimal dialysis therapy is not a remedy. There are abnormalities that develop after initiation of dialysis therapy like aluminium overload. The clinical consequence of aluminium overload includes a neurologic syndrome. This study was taken to find out aluminium concentrations in blood of CKD patients and to identify clinical co-relation with aluminium concentration on 25 patients (16 males and 9 females) of CKD undergoing hemodialysis at Bombay Hospital Institute of Medical Sciences, Mumbai. They were divided into 3 groups on the basis of duration of maintenance hemodialysis. Group I: > 1 year, Group II: 6 months to 1 year and Group III: < 6 months. For quantification of aluminium content, electro thermal atomic absorption spectrometry method was used and done at serology laboratory. Blood aluminium level in 25 patients was in range of 22.7 to 150.50 µg/L. (in group I were in range of 22.70 to 119.60 µg/L, in group II were in range of 23.70 to 150.50µg/L and in group III, it was in range of 47.90 to 121.40µg/L). Out of 25 patients, 11 patients had symptoms and aluminium blood levels ranging from 22.70 to 121.4090µg/L. In asymptomatic patients levels ranged from 23.790µg/L to 150.590µg/L. There was no significant relation of blood aluminium levels and symptoms (p=0.220). We conclude that the blood aluminium levels were high, which could be due to use of aluminum utensils and/or alternative medicine. They will need counseling regarding stopping of using alternative medicine and aluminium utensils.
**Keywords:** Aluminium, Chronic kidney disease, Dialysis

## INTRODUCTION:

Chronic Kidney Disease (CKD) is a pathophysiologic process with multiple etiologies, resulting in the reduction of nephron numbers and their functions and frequently leading to end stage renal disease (ESRD). In turn ESRD represent as a clinical stage or condition in which there has been an irreversible loss of endogenous renal function, of a degree sufficient to render the patient permanently dependent upon renal replacement therapy (dialysis or transplantation) in order to avoid life threatening uremia.

Uremia is associated with disturbances in fluid and electrolyte balance, endocrine-metabolic disturbance, neuromuscular disturbance, cardiovascular and pulmonary disturbances, dermatological disturbances, gastro-intestinal disturbances and hematologic and immunologic disturbances.

Dialysis helps to reduce the incidence of severity of these disturbances. Unfortunately, even optimal dialysis therapy is not a dialysis panacea because some disturbances resulting from impaired renal function fail to respond fully, while others continue to progress. There are also abnormalities that develop only after initiation of dialysis therapy, which are dialysis disequilibrium syndrome, hypotension, arrhythmias, vascular calcification, accelerated atherosclerosis, leucopenia, hypocomplementemia, bleeding diathesis, idiopathic ascites, and peritonitis and aluminium overload [1, 2].

The clinical consequence of aluminium overload includes a neurologic syndrome, disorders of

the hematological system and the development of so called aluminium related bone disease [3]. Aluminium a cause of encephalopathy was mentioned in literature since early 1970[4].

The use of deionizers of reverse osmosis (RO) filters for water purification and replacement of aluminium hydroxide by calcium containing phosphate binding agents have markedly reduced the incidence and severity of aluminium related disease. This study was taken to find out aluminium concentrations in blood of CKD patients undergoing hemodialysis at Bombay Hospital Institute of Medical Sciences, Mumbai.

**AIMS & OBJECTIVES:**

The aims and objectives of this study were

1. To detect serum aluminium concentration in blood of end stage renal disease patients on hemodialysis
2. To identify clinical co-relation with aluminium concentration
3. To identify co-relation of aluminium concentration with varying duration of hemodialysis
4. To identify the aluminium utensils as the source of aluminium

**MATERIAL & METHODS:**

In this study total 25 patients of Chronic Kidney Disease on maintenance hemodialysis attending AKD department of Bombay Hospital Institute of Medical Sciences, Mumbai were included. Span of study was from 2004 to 2005. The study was undertaken after taking prior permission from institute's ethical committee. This study was done to collect and analyze data so as to present it for appearing M.D. Medicine examination.

All the patients were explained about the importance of study and their consents were taken to participate. Detailed history of patients was taken including patients presenting symptoms, duration of diagnosis of CKD, treatment history since the diagnosis of CKD and prior to it and duration of maintenance hemodialysis.

Following history was specifically asked:

- History of aluminium toxicity viz. symptoms associated with anemia, bone involvement (spontaneous fractures, bone pain) and brain involvement (seizures, myoclonic jerks, speech disturbances and dementia)
- History of use of aluminium containing medications (phosphate binders antacids), use of alternative medicines and its duration
- History of using aluminum utensils for cooking
- Source of water for drinking
- Dose of erythropoietin per week

The age range was 19-68 years with mean age of 43.52 yrs. Out of 25 patients, 16 (64%) were males while 9 (36%) were females.

They were divided into 3 groups on the basis of duration of maintenance hemodialysis.

Group I: > 1 year
Group II: 6 months to 1 year
Group III: < 6 months

A detailed examination of all patients along with blood investigations were carried out. Pre-dialysis blood sample of patients were taken for aluminium estimation using syringes and needles without detectable aluminium release in plastic container. Estimation of serum aluminium was done at serology laboratory. For quantification of aluminium content, electrothermal atomic absorption spectrometry method was used.

**OBSERVATIONS:**

In this study of 25 patients, the age range was 19 to 68 yrs with a mean age of 43.52 yrs. Out of 25 patients, 16 (64%) were males while 9 (36%) were females. Following are the observations made in this study.

**Table 1: Distribution of patients in 3 groups**

| Group | No. of patients (%) | Male (%) | Females (%) |
|---|---|---|---|
| **Group I** | 8 (32) | 2(8) | 6(24) |
| **Group II** | 9(36) | 6(24) | 3(12) |
| **Group III** | 8(32) | 8(32) | 0 |
| **Total** | 25(100) | 16(64) | 9(36) |

**Table 2: Disease distribution**

| Disease | No. of patients | Percentage |
|---|---|---|
| Tubulointerstitial disease | 7 | 28 |
| Diabetic nephropathy | 6 | 24 |
| Obstructive nephropathy | 4 | 16 |
| Unknown etiology | 4 | 16 |
| Hypertensive nephrosclerosis | 3 | 12 |
| Chronic glomerulonephritis | 1 | 4 |

**Table 3: Symptoms of aluminium toxicity**

| Symptoms of aluminum toxicity | No of cases (%) | Male (%) | Females (%) |
|---|---|---|---|
| Symptoms of bone | 8 (73) | 3(28) | 5(45) |
| Symptoms of brain | 2(18) | 2(18) | 0 |
| Symptoms of anemia | 0 | 0 | 0 |
| All 3 symptoms | 1(9) | 1(9) | 0 |
| Total | 11(100) | 6(55) | 5(45) |

Out of 25 patients, 11 (44%) had symptoms could be suggestive of aluminium toxicity and 14% were asymptomatic. Out of 11 symptomatic patients, 6 (55%) were male and 5 (45%) were females.

**Table 4: Relation of blood aluminium levels with duration of maintenance hemodialysis**

| Study Group | No. of patients | Range of serum aluminium level (µg/L) | Mean | S.D. |
|---|---|---|---|---|
| < 6 months | 8 | 47.90 to 121.40 | 89.02 | 27.03 |
| 6 months-1 year | 9 | 23.70 to 150.50 | 66.31 | 45.90 |
| > 1 yr | 8 | 22.70 to 119.60 | 61.41 | 38.66 |
| Total | 25 | 22.70 to 150.50 | 72.01 | 38.69 |

P = 0.323 (not significant)

Pre-dialysis serum aluminium level in 25 patients was in range of 22.7 to 150.50 µg/L. Blood aluminium levels in group I (>1 year) were in range of 22.70 to 119.60 µg/L with a mean of 61.41 and standard deviation of 38.66. In group II (6 months-1 year) blood aluminium levels were in range of 23.70 to 150.50µg/L with a mean of 66.31 and SD of 45.90. In group III (< 6 months), it was in range of 47.90 to 121.40µg/L with a mean of 89.02 and SD of 27.3. Although there was difference in blood aluminium levels in each group but this was statistically not significant. (p = 0.323)

**Table 5: Relation of blood aluminium levels with symptoms**

| | No | Range of blood aluminium (µg/L) | Mean | S.D. |
|---|---|---|---|---|
| Asymptomatic | 14 | 23.70 to 150.50 | 63.45 | 39.96 |
| Symptomatic | 11 | 22.70 to 121.40 | 82.90 | 35.84 |
| Total | 25 | 22.70 to 150.50 | 72.01 | 38.69 |

p = 0.220 (not significant)

There was difference between the symptomatic and symptomatic patients which was not statistically significant. (p = 0.220)

**Table 6: Relation of blood aluminium levels with use of probable aluminum source**

| | No | Range of blood aluminium (µg/L) | Mean | S.D. |
|---|---|---|---|---|
| No | 10 | 22.70 to 47.90 | 30.83 | 7.47 |
| Yes | 15 | 63.40 to 150.50 | 99.46 | 22.63 |
| Total | 25 | 22.70 to 150.50 | 72.01 | 38.69 |

p = 0.000 (significant)

15 patients were using aluminium utensils for cooking, we thought as probable source of aluminium with range from 63.40 to 150.50µg/L and mean of 99.46 and SD of 22.63. 10 patients who were not using these aluminium sources had blood aluminium range from 22.70 to 47.90µg/L with a mean of 30.83 and SD of 7.47. There was difference in blood aluminium levels in patients who were using aluminium utensils as source from those who were not using it, which was statistically significant.
(p = 0.000)

**DISCUSSION:**

In our study we found that blood aluminium levels to be as minimum as 22.79µg/L and as high as 150.590µg/L with a mean of 72.0190µg/L and SD of 38.69. When the aluminium levels were correlated with duration of maintenance of hemodialysis, we found that in group I- mean blood aluminium levels were 61.41, in group II-mean aluminium levels were 66.3190µg/L and in group III-mean blood aluminium levels were 89.0290µg/L. There was a difference between these groups but not statistically significant.

A cross-sectional study on 1076 patients on chronic hemodialysis in Veneto (Italy) also states that there is no correlation of aluminium levels with duration of dialysis [5]. While Salusky IB *et al.;* [6] and Coburn *et al.;* [7] mentioned that patients on dialysis consuming aluminium hydroxide showed that aluminium levels increased with duration. With stopping of aluminium consumption for 6 months or more showed decrease in aluminium levels.

In our study we studied the relation of aluminium levels with symptoms. Out of 25 patients, 11 patients had symptoms and aluminium blood levels ranging from 22.70 to 121.4090µg/L with mean of 82.9 and SD of 35.84. In asymptomatic patients aluminium blood levels ranged from 23.790µg/L to 150.590µg/L with a mean of 63.45 and SD of 39.96. There was no significant relation of blood aluminium levels and symptoms (p=0.220).

Annamaria *et al.;* [8] did plasma aluminium levels and bone biopsies of 258 patients on dialysis, not having any symptoms and identified 26.75% of patients with aluminium bone disease. They concluded that although there is a correlation between high aluminium levels and aluminium bone disease, a patient's plasma aluminium level does not predict well the presence of aluminium bone disease in spite of relatively high prevalence of disease.

In this study we also tried to correlate blood aluminium levels with patients using aluminium utensils. We identified that this to be statistically significant (p=0.00). The range of aluminium levels in patients using this probable source is 63.4 to 15.090µg/L.

These findings correlate well with the findings mentioned in a study by Winney RJ *et al.;* [9], suggesting that only dialysate is not the source of high aluminium levels, but a low dose of aluminium exposure through external route can lead to high aluminium blood levels. Soni MG *et al.;* [10] states that cooking in aluminium utensils often result in statistically significant but relatively small increase in aluminium content of food, which can be significant in uremic patients. There has been recent evidence of heavy metal toxicity in patients consuming alternative medicine and so we can consider alternative medicines as a possible source of high aluminium levels along with aluminium utensils.

**CONCLUSION:**

Although our study included only 25 patients and the patients included were on maintenance dialysis for maximum 1 year, the symptoms ascribed as related to aluminium toxicity could be seen in many other conditions.

However we conclude that although the patients were not on aluminium containing medications still the blood aluminium levels were high, which could be due to use of aluminum utensils and/or alternative medicine. These patients may need low dose of desferroxamine [11] therapy and future monitoring of aluminium levels

in blood. They will also need counseling regarding stopping of using alternative medicine and aluminium utensils.

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