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ALUMINIUM CONCENTRATIONS IN PLASMA, BONE AND HAIR IN PATIENTS ON LONG-TERM HAEMODIALYSIS

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Summary

In 22 male and 29 female patients on long-term haemodialysis blood, bone and hair specimens were analysed for aluminium concentrations. The mean plasma and bone aluminium of the patients were increased, the mean hair aluminium being at the upper normal limit. In male patients a positive correlation between hair and bone aluminium could be found ($r=0.55$, $p<0.01$). In female patients there was no significant correlation between bone and hair aluminium, probably because of cosmetic hair treatments. Therefore, analysis of untreated hair can be used for evaluating aluminium status in males.

Introduction

The treatment with aluminium containing phosphate binders and antacids causes aluminium accumulation in patients with chronic renal failure due to a reduced or absent excretion of this compound. This mechanism is further enhanced by haemodialysis with aluminium containing water. The aluminium accumulation in these patients may result in the aluminium intoxication syndrome consisting of osteomalacia, progressive encephalopathy, microcytic anaemia and myopathy [1,2].

Although the exact mechanisms of aluminium toxicity are still unknown, it is well established that the tissue aluminium concentrations are elevated; furthermore, therapeutic measures in cases of the aluminium intoxication syndrome are practicable [3–5]. To get more information on the whole body aluminium it is necessary to determine the tissue concentration of this metal.

The easily available blood or plasma concentrations of aluminium correlate poorly with the tissue level and are therefore not useful for the assessment of total body aluminium [6,7]. On the other hand taking tissue specimen such as bone or gastric mucous membrane is combined with distress for the patient. Therefore the present study was undertaken to determine whether the analysis of hair as an easily available tissue allows estimation of the patient's aluminium

body burden. For this purpose aluminium measurements of hair, bone and plasma concentrations were carried out and compared.

Patients and methods

Fifty-one patients (22 males, 29 females) on chronic intermittent haemodialysis treatment for 46±36 months were evaluated. The mean age was 47.2 years (range: 21–74 years). Haemodialysis treatment was performed with dialysate prepared with reverse osmosis water. Each patient was interviewed to collect data on hair shampoos and cosmetics. Blood, hair and bone specimens were taken simultaneously. The bone samples were obtained by iliac crest biopsies with a Jamshidi-needle. Hair samples (250–500mg) were cut from the nape as close to the scalp as possible. Hair and bone specimens were wet ashed with concentrated nitric acid and the aluminium concentration determined by atomic absorption spectrophotometry. Plasma specimens needed no ashing before analysis [5,8].

Spearmen's rank correlation coefficients were calculated to assess the relation between bone, hair and plasma aluminium levels.

Results

Table I shows the mean (±SD) plasma, bone and hair aluminium in male and female patients. The tissue aluminium was independent of sex. In contrast plasma aluminium concentrations were higher in males (71.5±47.8μg Al/L) than in females (54.4±56.4μg Al/L). Whereas the mean hair aluminium concentration was in the upper normal range, the mean aluminium levels in plasma and bone were increased.

TABLE I. Mean aluminium concentrations (±SD) in plasma, bone and hair in male (n=22) and female (n=29) patients. Normal ranges are indicated

Mean aluminium concentrations in	Male patients n=22	Female patients n=29	normal
plasma	71.5±47.8	54.4±56.4	<35μg Al/L
bone	16.5±18.7	16.7±13.3	<6μg Al/L
hair	10.5±9.1	10.1±7.4	<10μg Al/L

In general, there were no significant correlations between plasma and hair aluminium, in contrast a weak correlation between plasma and bone aluminium was observed ($r=0.26$; $p<0.1$). Bone and hair aluminium concentrations were weakly correlated in the total group ($n=51$, $r=0.3$, $p<0.05$), whereas there was no correlation in the group of female patients ($n=29$, $r=0.04$, p=NS) unlike male patients ($n=22$, $r=0.55$, $p<0.01$) (Figures 1 and 2). Twenty-seven out of 29 female patients but no male patient had had a hair beauty treatment such as dyeing or conditioning. Most female patients used a hair spray.

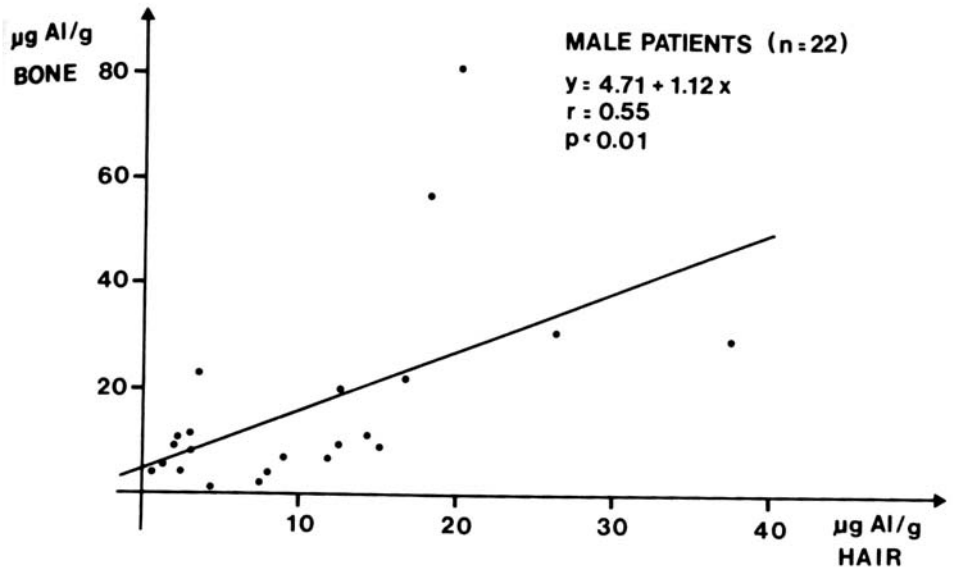

Figure 1. Correlation between bone and hair aluminium concentrations in 22 male patients ($y=4.72 + 1.12\ x$; $r=0.55$; $p<0.01$)

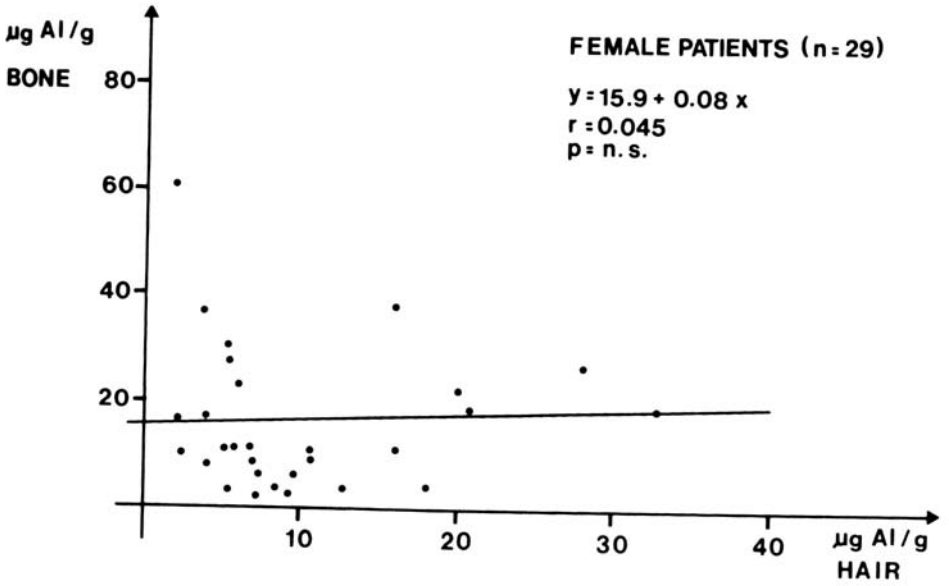

Figure 2. Correlation between bone and hair aluminium concentrations in 29 female patients ($y=15.9 + 0.08\ x$; $r=0.045$; $p=NS$)

Discussion

Recent studies reveal no correlation between plasma and bone aluminium concentrations [6]. In contrast, the present study indicates a trend between plasma and bone aluminium. Since several reports on patients with dialysis osteomalacia show low and high plasma aluminium it still remains open whether the plasma aluminium concentration allows for the assessment of tissue aluminium [2,5]. These data rather demonstrate that a single plasma aluminium determination gives no reliable information on the aluminium body burden. This information can only be obtained from tissue examinations. Therefore the bone aluminium is so far the only valid parameter for estimating an aluminium accumulation in patients with chronic renal failure. The present study aims at defining more easily available procedures to assess the aluminium body burden such as by analysing hair specimens. Taking a hair specimen means no embarrassment to the patient; the storage of samples is easy because there is no need for special storage conditions [9].

In the group of male patients there was a positive correlation between bone aluminium and hair aluminium ($r=0.55$, $p<0.01$); thus, hair aluminium gives information about the aluminium status in these patients. No correlation between plasma and hair aluminium concentrations could be found. These findings are consistent with those found by McBean et al analysing hair and plasma zinc concentrations [10].

The explanation for the fact, that no significant correlation between hair and bone aluminium could be found in female patients, may be given by hair treatments such as bleaching, dyeing or conditioning which were shown to alter trace element concentrations [9].

Therefore for a reliable determination of hair aluminium it must be determined that there was no cosmetic treatment of the hair in the past months. To avoid misinterpretation due to varying aluminium distributions in the scalp it is necessary to take hair always from the same region of the head (from the nape).

This study demonstrates that hair analysis can be used as a clinical tool to evaluate the aluminium status in male patients and therefore provides an easily available alternative to the assessment of bone specimens.

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