SERUM CALCIUM AND PARATHYROID HORMONE LEVELS IN ALUMINUM POTROOM WORKERS EXPOSED TO FLUORIDE EMISSIONS

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SUMMARY: In this cross-sectional study we examined 200 aluminum potroom workers in Arak, Iran, for their serum calcium, serum parathyroid hormone (PTH), urinary creatinine, and preshift urinary fluoride (F). Individual data were analyzed in relation to age and work duration. The mean serum PTH measured with enzyme linked immuno sorbent assay (ELISA) was 53.84±27.69 pg/mL with 16% of workers having serum PTH assays higher than the upper normal range limit of 76.6 pg/mL. Urinary F measured by the ion selective electrode showed a mean of 2.258±1.426 mg F/g of urinary creatinine, with 46 (23%) of workers having levels more than 3 mg F/g of urinary creatinine. Among the potroom workers, there was a highly significant positive relationship between serum PTH and work duration ($p<0.003$). These results confirm that excessive chronic F exposure can elevate serum PTH levels.

Keywords: Aluminum potroom workers; Industrial fluoride exposure; Parathyroid hormone; Serum calcium.

INTRODUCTION

The electrolytic reduction of alumina (Al_2O_3) dissolved in temperature-lowering cryolyte (Na_3AlF_6) and fluorspar (CaF_2) to yield aluminum metal is conducted in large electrolytic cells called pots arranged in rows. Gaseous and particulate fluoride (F) emissions are a significant occupationally health hazard in these potrooms. Lungs, bones, and internal organs are known to be affected by such airborne F. Moreover, neurobehavioral dysfunction in aluminum potroom workers and hypocalcemia related to F exposure has also been reported.[1-2] Likewise, elevated serum parathyroid hormone (PTH) has been found in F-treated animals,[3] and earlier research indicates that F can decrease ionic serum calcium.[4-5] Other studies have also shown that F can lower the level of plasma calcium level; secondary PTH elevation results in increased plasma calcium and urine phosphorus levels.[6] According to Huang's survey, F workers had elevated serum PTH level that correlated with urinary F.[7] Many F adverse effects studies on parathyroid glands are reviewed in the 2006 US National Research Council (NRC) report.[8]

Because there appears to be limited information about serum calcium and PTH in aluminum potroom workers exposed to F in primary aluminum production, especially with older technology, the present study was undertaken.

MATERIALS AND METHODS

In this cross-sectional study, several laboratory tests of 200 aluminum potroom workers were undertaken. Individual data about age and work duration in the potroom were obtained from Health Safety Environmental (HSE) unit of the

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factory. All subjects were healthy males without a history of chronic disease and drug consumption. Fasting peripheral blood sample and preshift urinary samples were taken. Serum calcium, serum PTH, urinary creatinine, and preshift urinary F levels were then measured. Serum calcium was measured by colorimetry with a normal range of 8–11 mg/dL. Intact PTH was measured using enzyme linked immuno sorbent assay (ELISA) with a normal range of 8/8–76/6 pg/mL. Urinary fluoride was measured with an ion selective electrode. Urinary creatinine was measured by the Jaffe method using a kit supplied by Pars Azmon, Iran. Correlation and regression analyses were conducted on these variables.

RESULTS AND DISCUSSION

The mean worker age was 35.76±4.55 years, and their work duration in the potroom was 11.12±4.49 years. Mean and standard deviations of the variables in this study are shown in the table. Thirty-two (16%) of the potroom workers had a serum PTH higher than the normal upper limit of 76.6 pg/mL. Serum calcium levels, however, were within the normal range in all workers. On the other hand, a highly significant ($p<0.003$) positive relationship (correlation coefficient=0.214) was found between work duration in the potroom and elevation of serum PTH in correlation and regression analysis. However, there was no significant relationship between serum PTH and age in correlation analysis ($p=0.091$) and between serum PTH and urinary F ($p=0.422$) or urinary F/g creatinine ($p=0.648$). Preshift urinary F/g creatinine in 46 workers (23%) was higher than the ACGIH recommendation (>3 mg F/g creatinine) for preshift urinary F.[9] Urinary F in two subjects was not detectable with the ion selective electrode method.

Although hypocalcemia associated with high F ingestion is known to lead to secondary hyperparathyroidism and acceleration of toxic effects of F on the skeletal system, our observations did not show a significant relationship between urinary F and elevation of serum PTH. On the other hand, as seen in the table, the urinary F levels of the potroom workers indicated they had a significant occupational exposure to F emissions. Moreover, as already noted, although their serum calcium levels were in the normal range, their serum PTH levels showed a significant positive relationship with work duration in the aluminum potrooms.

Table. Number, observed range, mean, standard deviation, and normal ranges of the variables

Variable	Number	Observed range	Mean±SD	Normal range
Calcium serum level (mg/dL)	200	8.1-10.7	9.289±0.41	8-11
PTH serum level (pg/mL)	200	14.9-201.5	53.846±27.69	8.8-76.6[a]
Urinary creatinine (mg/dL)	200	20-195	89.735±35.53	32-241[b]
Urinary F (mg/L)	198	0.21-1.81	1.817±1.164	0.1[c]
Urinary F/creatine (mg/g)	198	0.3-8.18	2.258±1.426	3>[d]

[a]Normal range according to used kit; [b]Normal range in US population;[10] [c]Normal urinary upper limit;[11] [d]According to ACGIH recommendation for preshift urinary fluoride.[9]

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