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Analysis of Electrolyte Imbalance in Human Fluorosis

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Abstract -- **Fluoride consumption through drinking water above the permissible limit can cause fluorosis which affects the teeth and bones as well as excess fluoride disrupt the equilibrium of electrolytes, essential for maintaining cellular homeostasis. Therefore the objective of the present study was to elucidate the effect of high fluoride in drinking water on electrolyte in fluorotic population (subject group), selected from endemic high fluoride (0.48 to 5.99 mg/L) areas of Maharashtra, India. The population was investigated clinically and biochemically in which the levels of calcium, sodium and potassium were determined in serum of fluorotic population and compared with control group. A significant decrease in serum calcium (5.0 ± 1.2778***), significant increase in serum sodium (141.1 ± 7.7385*) and serum potassium (4.2 ± 0.8230**) level was found in the subjects group as compared to control groups. The findings of this study provide evidence that fluoride can have harmful effects on electrolytes.**

Keywords--**Fluoride, Drinking Water, Electrolytes.**

I. INTRODUCTION

Fluorine occurs in environment in combination with other elements as a fluoride compounds. Human beings are exposed to fluoride majorly through drinking water (Teotia and Teotia, 1994) which leads to endemic fluorosis in rural India. Prolonged ingestion of water with excess fluoride resulting in dental and skeletal morbidity. The toxic effects of fluoride on skeletal system are multifactorial reduced intestinal calcium absorption and altered bone remodeling. Fluoride ion acts by inhibiting sodium potassium ATPase that stimulate sodium and calcium exchange and conduces to increase kalemia (Nicolay et al, 1999). Fluoride combines with calcium to form calcium ionospheres that easily permeablize the cell membrane. The effect of fluoride depends on extracellular calcium and can be blocked by a combination of calcium channel blocking agents, suggesting that potentiation of channel activity is dependent on external calcium (Harinarayan et al, 2006).

With a high fluoride intake, insoluble calcium fluoride is formed in the intestine and excreted in faeces, increasing the likelihood of a low blood calcium if there is an insufficient dietry intake. In addition rural population have other nutritional deficiencies in particular calcium owing to dietary deficiency.

Calcium absorption through intestine and excretion through kidney is tightly regulated. Electrolytes like sodium, potassium, and calcium are the important markers of kidney function (Bhardwaj and Shashi, 2012). Moreover, fluoride disrupts the equilibrium of electrolytes, including sodium, potassium, and calcium, essential for maintaining cellular homeostasis and proper kidney function (Lavanya et al, 2024).

The deleterious effects of fluoride on the soft tissues including kidneys have been studied well in different experimental models (Maiti and Das, 2004 and Zhan et al., 2006) but the studies which investigate the effects of fluoride on soft tissue and skeletal of human population are very few. Earlier studies on fluoride contamination in ground water (Kodate et al, 2016) as well as effect of fluoride toxicity on human population like symptoms of skeletal fluorosis (Dhawas et al, 2013) and haematological indices (Dhawas et al, 2021) strongly evident for fluoride toxicity in study area. Therefore in the light of the above findings, the present investigation was aimed to evaluate the effect of high fluoride on serum electrolytes.

II. MATERIALS AND METHODS

Study Area

The Warora tehsil of Chandrapur district of Maharashtra is endemic for fluorosis showing high fluoride levels in drinking water and selection of Dongergaon village for present study from Warora tehsil was made on the basis of available information from our earlier ground water analysis which shows the high fluoride content in drinking water (Kodate et al, 2016). It is located between 20º 21’33.4” N to 20º 19’45.9” N latitudes and 79º 02’04.8” E to 78º 57’35.7” E longitudes, covering an area 342.46 hectares.

Selection of Subject and Control Group

Subject group was selected on the basis of fluoride concentration in their serum samples and showed symptoms of skeletal fluorosis. The skeletal fluorosis was diagnosed clinically. The control group was selected from Warora city where water fluoride level in drinking water was below the permissible limit.

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Collection of Blood Samples

After collection of those data, the blood samples were collected from the diagnosed cases of skeletal fluorosis, subject group and control group in non-reactive plastic vials and brought to the laboratory in an ice box for further electrolyte analysis. The electrolytes studied in the collected samples of blood were calcium, sodium and potassium.

The obtained values of serum electrolytes were analyzed by comparing means and represented by Mean ± SD with the help of commercially available software package SPSS. The values considered significant were represented by an asterisk.

III. Results And Discussion

The analysis on blood samples of subject group which shows the significant elevated mean serum fluoride level (0.3 ± 0.2368***mg/L) in our previous examination as well as symptoms of skeletal fluorosis and control group were studied which includes serum electrolytes calcium, sodium and potassium. The concentration of calcium in the serum of control group measured about 9.3 ± 0.4525 mg/dl which decreased highly significant to 5.0 ± 1.2778*** mg/dl in the subjects group as compared to control group. Serum sodium level of control group measured about 138.2 ± 5.9611 mmol/L and it increased significantly to 141.1 ± 7.7385* mmol/L and serum potassium level of control group measured about 3.9 ± 0.4507 mmol/L which also increased significantly to 4.2 ± 0.8230** mmol/L in the subjects group as compared to control groups (Table 1).

TABLE 1
Serum Electrolytes of Control and Subject Group

S. N.	Parameters (Unit)	Group	Mean±SD
1	Calcium (mg/dl)	Control	9.3 ± 0.4525
		Subject	5.0 ± 1.2778***
2	Sodium (mmol/L)	Control	138.2 ± 5.9611
		Subject	141.1 ± 7.7385*
3	Potassium (mmol/L)	Control	3.9 ± 0.4507
		Subject	4.2 ± 0.8230**

(***p < 0.001, **p < 0.01, *p < 0.05, n = 100)

It is well known that ionic calcium is one of the important ion for the initiation and maintenance of activity of vital organs and muscular skeletal system. Calcifications of arteries in association with fluorosis have been reported by numerous investigators Kumar and Harper, 1963; Mohamedally and Wix, 1983 and Susheela and Kharb, 1990.

Fluoride strongly binds to calcium, its result in hypocalcaemia and hyperkalemia (Dure-Smith et al., 1996 and Khandare et al., 2007). Similarly decrease serum calcium level or hypocalcaemia is observed in the present study, it could be attributed to ectopic calcification in soft tissues. The similar observations are also reported by Shanthakumari and Subramanian, 2007 and Karademir et al., 2011. Some studies reported a contradictory result in which the level of calcium increase in fluoride toxicity (Teotia et al., 1979 and Shivashankara et al., 2000).

The level of sodium and potassium concentrations increases significantly in the present study. The increase in these two electrolytes could be due to fluoride-induced potassium efflux from cells (McIvor et al., 1985). The results are in agreement with Michael et al., 1996; Shanthakumari and Subramanian, 2007 and Karademir et al., 2011. Controversial result is also reported by Suketa and Terui, 1980 in their study the serum sodium level in rats after fluoride administration reduced while potassium stimulate significantly. They attributed these changes to alteration in adrenal function. Shivashankara et al., 2000 found markedly reduced serum potassium level whereas no significant difference in serum level of sodium in children with chronic fluorosis.

IV. Conclusion

Thus, it is concluded that fluoride concentration above the permissible limit in drinking water affects population residing in the study area. There is an urgent need of fluoride free drinking water supply, defluoridation of currently available water sources and their constant monitoring as well as awareness about deleterious effects of fluoride toxicity.

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