# CHANGES OF SOFT TISSUE FUNCTIONS IN INVIDUALS HAVING FLUOROSIS IN RURAL BANKURA DISTRICT WEST BENGAL.

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**ABSTRACT**: The present study was conducted to find out various health hazards related to high consumption of fluoride either by water or food in endemic areas of Bankura district,WB,India.The study revealed high levels of serum/urine fluoride content and relevent clinical outcome like mottling of teeth and skeletal deformity on prolonged exposure of fluoride. Consumption of fluoride causes lowering of haemoglobin and serum protein levels.

There are no significant changes of serum cholesterol whereas circulating testosterone is decreased without affecting the reproductive functions. The increased levels of serum transaminase, shows functional hepatic changes following prolonged exposure of fluoride. The changes in serum calcium, sodium and potassium causes electrolyte imbalance in the exposed individuals without any sex variation. A significant increase in the thyroxine (T 4) suggests an alteration in thyroid function, without any changes of thyroid stimulating hormone (TSH) and tri-iodothyronine (T3), thus the study revealed some deleterious effects of fluoride in the tissue functions of various vital organs of the endemic population.

**KEYWORDS:** Fluorosis, Soft Tissue changes, Hypothyroidism

**INTRODUCTION:** Fluorosis deleloped by intake of fluoride by consumable water/food and has been identified in India for six decades[1]. It is a slow, progressive crippling malady, affecting young and old, rural and urban populations with recently attained alarming dimensions. It is widespread in as many as 15 states of the Indian Republic, afflicting some 25 million people [2]. In West Bengal out of 18 districts 4 districts are worstly affected by Fluorosis[3]. Bankura is one of them where near about 1 lakh populations are affected by Fluorosis[3].Agricultural crops, water and food are contaminated with fluoride following high concentration of fluoride in the soil in endemic areas. The Geological Survey of India reveals that topaz, apatite, rock phosphate, phosphate nodules and phosphorite are widespread in the earth's crust in India and contain highest percentage fluoride [5]. As a result of the rich mineral content and high rainfall, fluoride leaches out and contaminates the water and the soil. Fluoride is known to affect the dental and skeletal systems. In addition, studies carried out in the past few years have shown detrimental effects on tissue functions of various organs mal models. Its effect on tissue functions on various vital organs on humans is less understood so our study is to find out the tissue changes on fluoride toxicity. We have carried out surveys in the fluoride endemic areas of Bankura (W.B) by the help of Department of Biochemistry, B.S. Medical College. & Hospital, Bankura, WB, India.

**MATERIALS AND METHODS:** Five hundred individuals covering fifty-two villages of Bankura district of West Bengal were initially examined. Individual record sheet having name, age, sex, address, source of consumable drinking water , depth of the well or pond, duration of stay in the village, food habits, dental changes and skeletal changes. Sample of consumable water and blood collected from fluoride exposed individuals. Fluoride levels measured from water and blood sample.

**SELECTION OF CONTROL INDIVIDUALS:** Similar consumable water and blood samples are collected from urban area of Bankura town, WB where fluoride content in water follows permissible limit recommended by Indian Bureau of Standards[6].

**The following parameters are studied in Study and Control populations:**

Fluoride content of drinking water and blood are determined with an Ion selective electrode, made by Orion Model 9609BNWF, and expressed as ppm (parts per million)[8]. Haemoglobin was determined by Sahli's method hemoglobinometer, and expressed in g%. Serum protein estimated by biuret method and expressed in g/dl [6].

Serum cholesterol determined by Pearson's method and expressed as mg/dl. Serum glutamate pyruvate transaminase (SGPT) and serum glutamate oxaloacetate transaminase (SGOT) are estimated by Reitman and Frankel"method [7] and expressed as IU (International Unit). Serum. Calcium, sodium and potassium levels were estimated by a Flame Photometer (Systronic digital unit type 125)[8] and expressed in mEq/L.

**SERUM HORMONES:** Serum Testosterone are assayed by the ELISA method [10] and expressed as ng/mL Serum. Tri-iodothyronine and thyroxine (T3 and T4) are determined by ELISA method and expressed as ng/mL. Thyroid stimulating hormone (TSH) serum levels are determined by the ELISA method and expressed in uU/mL. Serum catecholamines are determined by Von Euler and Hamberg method and expressed ug/mL serum [10].

**RESULTS:** Surveys conducted in 52 villages of Bankura(W.B) revealed symptoms of fluorosis in the majority of the individuals studied. 74% of the individuals showed slight to severe mottling of teeth. 59% had stiffness of spinal cord. Other skeletal problems such as stiff hands and fingers (60%), stiffness of legs and joints (65%) were also common and 93% of the cases studied having the habit of regular tea intake.

**WATER FLUORIDE CONTENT:** Water samples from various places of Bankura town showed fluoride levels within the permissible limit (recommended level of fluoride 0.6 ppm) whereas samples collected from endemic villages of Bankura revealed high fluoride contents, ranging in this survey (Table 1) from 1.0 to 6.53 ppm. In 52 villages 18 (35%) had fluoride content below 2 ppm and 26 (50%) had fluoride content within the range of 2-4 ppm while 8 (15%) had fluoride levels above 4 ppm. Bore water samples had higher fluoride concentrations than well water samples [11].

Tables 1-4 present that fluoride exposed individuals, when compared to controls, had significantly increased serum levels ($P < 0.001$) of fluoride, SGOT, SGPT, sodium and potassium, and serum cholesterol levels were essentially the same in both populations.

In this survey, there was an decrease in mean of serum testosterone levels in the fluoride exposed individuals, compared to controls.

**SERUM FLUORIDE:** In 80 samples analysed, 38% had fluoride concentration < 0.2 ppm; 47% showed fluoride levels in the range 0.2-0.4 ppm; while 15% showed above 0.4 ppm (Table 1). Fluoride concentration increased with age (Figure).

**Haemoglobin:** levels of the fluoride exposed group showed an insignificant decrease when compared to the control population (Table 2).

**Serum cholesterol:** levels are essentially the same for both fluoride exposed populations and controls (Table 2).

**Serum protein and calcium:** Levels of the endemic population showed a highly significant decrease ($p < 0.001$) as compared to the control (Tables 3 and 4).

**Serum triiodothyronine (T3) and thyroid stimulating hormone (T5):** There was no difference in levels in the fluoride exposed and control groups (Table 5).

**Serum thyroxine** (T4): levels showed a significant increase ($P < 0.001$) compared to control (Table 5).

**Serum catecholamines:** The serum adrenalin and nor-adrenalin levels increased significantly in fluoride exposed individuals ($P < 0.001$) compared to controls (Table 6).

**TABLE- 1.** Water and serum fluoride levels (ppm) in control and endemic population

| Parameter | Control | Endemic Population |
|---|---|---|
| Water fluoride | 0.638 ± 0.013 | 2.70 ± 0.18 |
| Range | 0.56 - 0.72 | 1.0 - 6.53 |
| No of cases | 15 | 52 |
| Serum fluoride | 0.04 ± 0.002 | 0.284 ± 0.032 |
| Range | 0.03 ± 0.05 | 0.131 ± 0.552 |
| No of cases | 15 | 76 |

**TABLE- 2.** Haemoglobin (g%), serum cholesterol (mg/dl) and testosterone (ng/mL)

| Parameter | Control | Endemic Population |
|---|---|---|
| Haemoglobin | 13.3 ± 0.339 | 12.89 ± 1.48 |
| Range | 11.8 - 16.4 | 7.8 – 16.0 |
| No of cases | 22 | 75 |
| Cholesterol | 155.22 ± 7.51 | 148.25 ± 3.90 |
| Range | 122.5 - 200 | 64.0 - 192.30 |
| No of cases | 15 | 40 |
| Testosterone | 6.42 ± 0.423 | 5.56 ± 0.49 |
| Range | 4.3 - 9.3 | 1.10 – 11.5 |
| No of cases | 15 | 35 |

**TABLE- 3. SGOT, SGPT (IU/L) and serum protein (gm/dl) levels**

| parameter | Control | Endemic Population |
|---|---|---|
| SGOT | 16.02 ± 1.2 | 29.38 ± 0.83 |
| Range | 12.0 – 24.0 | 23 - 41 |
| No of cases | 15 | 35 |
| SGPT | 11.7 ± 0.83 | 22.33 ± 0.73 |
| Range | 9 - 15 | 35 |
| No of cases | 15 | 35 |
| Protein | 8.64 ± 0.144 | 5.76 ± 0.89 |
| Range | 7.924 – 9.42 | 4.15 ± 6.98 |
| No of cases | 15 | 35 |

**TABLE- 4 - Calcium, sodium and potassium levels (mEq/L)**

| parameter | Control | Endemic Population |
|---|---|---|
| Calcium | 0.958 ± 0.045 | 0.595 ± 0.014 |
| Range | 0.71 – 1.15 | 0.40 - 0.79 |
| No of cases | 15 | 60 |
| Sodium | 1163.68 ± 28.84 | 1875.59 ± 30.8 |
| Range | 861 - 1500 | 1320 - 2450 |
| No of cases | 22 | 60 |
| Potassium | 129.35 ± 7.96 | 322.75 ± 42.38 |
| Range | 90 - 120 | 130 - 820 |
| No of cases | 22 | 60 |

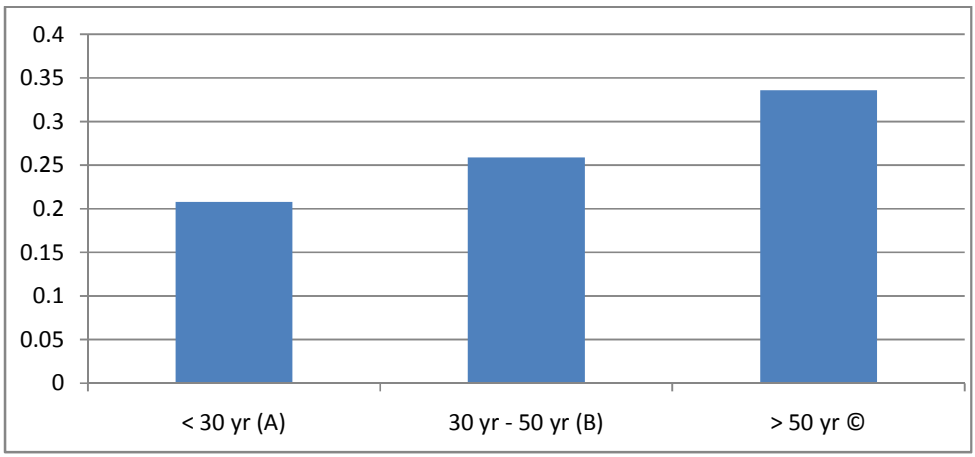
**TABLE- 5.** Serum T3, T4 and TSH

| parameter | Control | Endemic Population |
|---|---|---|
| T3(ng/mL) | 1.50 ± 0.135 | 1.528 ± 0.076 |
| Range | 0.7 – 2.1 | 1 – 3.7 |
| No of cases | 15 | 40 |
| T4(ng/mL) | 9.16 ± 0.63 | 14.77 ± 0.512 |
| Range | 5.4 - 13 | 7.2 - 20 |
| No of cases | 15 | 40 |
| TSH(μU/mL) | 2.56 ± 0.36 | 2.55 ± 0.37 |
| Range | 0.50 – 4.4 | 0.30 – 6.1 |
| No of cases | 15 | 55 |

**TABLE- 6. Catecholamine levels (pg/mL) in serum**

| parameter | Control | Endemic Population |
|---|---|---|
| Adrenalin | 220.67 ± 20.79 | 332.61 ± 20.54 |
| Range | 157.46 - 311.60 | 114.20 - 788.51 |
| No of cases | 15 | 50 |
| Nor-adrenalin | 164.51 ± 11.19 | 514.87 ± 35.27 |
| Range | 118.51 - 235.0 | 108.64 - 1053.07 |
| No of cases | 15 | 50 |

FIGURE. Age dependent variation in serum fluoride concentrations among endemic population. A: below 30 year. B: 30- 50 years. C: Over 50 years.




**DISCUSSION:** The study of various health hazards following prolonged exposure of fluoride in Bankura district of South Bengal revealed a wide occurrence of fluorosis, ranging from mild to acute[13].

The concentration of fluoride ions in plasma is directly related to the fluoride content of the drinking water [12]. This close relationship has been clearly demonstrated by several authors[7,9,12,14].

In this study, when the individuals were divided into three age groups (under 30 year, 30-50 year, and over 50 year), an increase in serum fluoride levels with age was observed (Figure). Plasma fluoride increased with age between 10 and 38 years. This difference in serum fluoride levels could be attributed to a difference in fluoride uptake by the skeleton. The young, growing skeleton, being low in fluoride, has a greater capacity for taking it up. In older people, the bone fluoride is higher and the plasma approaches equilibrium with it, hence it occurs with a rise in plasma fluoride with advancing years.

There are only a few reports in the literature of anemia in fluoride exposed individuals. Haemoglobin levels in the endemic villages were low, compared to those in the control population. Though the difference between mean values was not significant, individual values in the endemic population showed great fluctuation. Though fluoride is capable of causing anemia, the haemoglobin level is also governed by the individual's nutritional status[6].

Fluoride is known to inhibit protein synthesis, mainly due to impairment of peptide chain initiation and by interfering with peptide chains on ribosomes. In the present study

protein levels in the endemic area were significantly decreased, which would adversely affect the growth of the affected individuals.

Conflicting reports have been published regarding fluoride toxicity and lipid metabolism [4]. The results of the present investigation revealed normal levels of serum cholesterol, thus ruling out the occurrence of hypo/hypercholesterolemia among fluorotic individuals in the early stages of the disease.

The circulating levels of testosterone in fluoride exposed individuals are also not altered significantly in males.

Chronic cases of fluoride exposed individuals need to be investigated in detail since the chances of atherosclerosis cannot be ruled out. Numerous investigators have reported calcification of arteries in association with skeletal fluorosis in high fluoride endemic areas. The decreased levels of serum calcium in the fluoride exposed individuals could be attributed to ectopic calcification in soft tissues. It could also be due to a decrease in the intestinal absorption of fluoride since fluoride is known to produce insoluble complexes with calcium. Further studies are necessary on endemic human populations to establish the role of fluoride atherosclerosis.

Calcium homeostasis is controlled by hormonal regulation of the thyroid and parathyroid glands[11]. In the present study, no significant change was observed in the levels of thyroid stimulating hormone (TSH) and T3 in the fluoride exposed individuals. An enhancement was observed in the levels of T4, which might be due to enhanced iodination to form this hormone rather than T3 which would result in its increased synthesis/release by the gland.

In fluoride exposed individuals the serum catecholamines were increased significantly, which would have a stimulatory effect on the sympathetic nervous system[9], thus influencing the hypothalamus gonadal axis and result in marked changes in reproductive functions. It would also affect the carbohydrate metabolism by accelerating the breakdown of glycogen.

The increased levels of serum transaminases in fluoride exposed individuals suggest alteration in liver function[5]. These levels increase several times if cellular damage occurs in the liver, so these enzymes are markers for assessing liver function.

The fluoride exposed group showed marked alteration in their serum electrolyte levels. Potassium and sodium levels increased significantly, compared to controls. Differential distribution of these two cations is essential for normal membrane function and integrity. Serum potassium is an indicator of cell damage. Increased levels suggest cell deterioration.

**CONCLUSION:** The present study revealed wide occurrence of fluorosis in the Bankura districts of West Bengal. Intake of high fluoride alters the normal body metabolism of the individuals. Further surveys are required in fluoride endemic areas, to reveal the magnitude of the problems caused by fluoride. The Government should take steps to supply safe drinking water in the villages affected by fluorosis.

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