ORIGINAL RESEARCH

A comparative study of fluoride ingestion levels, serum thyroid hormone & TSH level derangements, dental fluorosis status among school children from endemic and non-endemic fluorosis areas

¹Dr. Apurva Vaidya, ²Dr. Shilpa Kaundal, ³Dr. Ridhima, ⁴Dr. Aditi Chauhan, ⁵Dr. Ankur Sharma, ⁶Dr. Vaishali Mangotra

¹MDS Pediatric and Preventive Dentistry, Director at Chamba Smile Dental Clinic, H.P., India ²MDS Peridontology & Oral Implantology, Dental Surgeon at New life Hospital Rohru H.P., India ³MDS, Pediatric and Preventive Dentistry, India

⁴MDS Pediatric and Preventive Dentistry, Director at SMITAM The Dental Studio, Yamunanagar, HR, India ⁵Senior Resident, Department of Dentistry, Pt. J.L.N.G.M.C & H, Chamba, H.P., India ⁶Dental Surgeon, Guru Nanak mission Hospital, Nanak Nagar, Jammu, India

Corresponding author

Dr. Ankur Sharma

Senior Resident, Department of Dentistry, Pt. J.L.N.G.M.C & H, Chamba, H.P., India

Received: 26 June, 2023

Accepted: 20 July, 2023

ABSTRACT

Background: An investigation comparing fluoride ingestion levels, disruptions in serum thyroid hormone and TSH levels, as well as the prevalence of dental fluorosis, was conducted among school children residing in regions affected and unaffected by fluorosis.

Materials & Methods: The study included a total of 20 school children, with ages ranging from 9 to 16 years, selected from both regions affected and unaffected by fluorosis. A separate Group 2 comprised 10 children from a non-endemic area, functioning as the control group. The resulting data were subjected to analysis using SPSS software

Results: The levels of thyroid hormones (FT3 & FT4) and TSH in bodily fluids were measured for both Group 1A and 1B, as well as for the 10 children in Group 2. Among these measurements, the concentration of FT4 was found to be highest in Group 1A, whereas the levels of TSH were notably elevated in Group 1B. **Conclusion:**Children residing in endemic fluorosis areas who exhibit dental fluorosis might not necessarily develop thyroid diseases as a direct result of excessive fluoride consumption. However, they do display thyroid-related issues that can have significant health implications. **Keywords:** fluorosis, children, thyroid hormone.

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Introduction

The problem of elevated levels of fluoride in groundwater is prevalent in many regions of Pakistan. It was very first recognized in Punjab by Wilson in 1941 in the town of Raiwind. ¹ Currently, fluorosis is endemic in many areas of Sindh, Balochistan and Punjab, affecting millions of people with a remarkable ratio of children. ² However, the problem of excessive fluoride in ground water is widespread throughout the world and approximately 200 million individuals among 25 countries are under the terrible providence of fluorosis including India, China, Sri Lanka, Spain, Italy, West Indies and America. ^{3,4} For example in India alone 21 states out of 29 and 65

million people including 6 million children are affected by fluorosis. ⁵ In Pakistan, out of 29 major cities 34% had water fluoride greater than 1.5×106 ng/L including Lahore, Quetta and Tehsil Mailsi with maximum values of 23.6 ×106 and 24.48 ×106 ng/L, respectively.⁴ A large number of human activities increase fluoride in the environment, including chemical production plants, waste pools, production of aluminum, steel, glass, enamel, brick, tile, pottery, and cement, manufacture of fluoride containing chemicals, phosphate fertilizers and metal casting, welding, and brazing. ⁶ In 2002, a study reported in India showed fluorosis in 10% of children, even when the concentration of fluoride in water was 1.0×106

ng/L.⁷ Thyroid diseases are one of the commonest endocrine disorders worldwide including India with about 42 million people suffering from it.⁸ Considering a potential association between fluoride exposure to endocrine disruption especially thyroid, many in-vitro experimental, animals and human studies have been published with more concern on thyroid. 9,10 But there exists a lack of clarity. Few studies reported that excessive long-term intake of fluoride, is a significant risk factor for the development of thyroid dysfunction. ^{11,12} One study in 1999 reported significant reduction in serum thyroxin (T4) with increased levels of triiodothyronine (T3); thyroid-stimulating hormone (TSH). ¹³ Another study in 2001 reported T3 and T4 concentrations in the serum of the patients with endemic fluorosis were significantly below the normal reference value. ¹⁴ Incontradiction few studies have indicated that the high fluoride intake does not have any effect on thyroid function. ¹⁵ Hence, this study was collected to compare fluoride ingestion levels, disruptions in serum thyroid hormone and TSH levels, as well as the prevalence of dental fluorosis, was conducted among school children residing in regions affected and unaffected by fluorosis.

Materials & Methods

The study included a total of 20 school children, with ages ranging from 9 to 16 years, selected from both regions affected and unaffected by fluorosis. Among these participants, those from areas with endemic fluorosis constituted Group 1, comprising an equal distribution of 5 males and females divided into two subgroups: Group 1A, consisting of children exhibiting dental fluorosis, and Group 1B, consisting of children without dental fluorosis. A separate Group 2 comprised 10 children from a non-endemic area, functioning as the control group. The investigation involved measuring serum concentration and fluoride levels, as well as conducting laboratory analyses. The resulting data were subjected to analysis using SPSS software.

Results

The levels of thyroid hormones (FT3 & FT4) and TSH in bodily fluids were measured for both Group 1A and 1B, as well as for the 10 children in Group 2. Among these measurements, the concentration of FT4 was found to be highest in Group 1A, whereas the levels of TSH were notably elevated in Group 1B.

Table 1: Levels of fluoride naturally ingested from drinking water and body fluids in different sample

groups						
Parameters	Group 1A	Group 1 B	Group 2			
Water fluoride	1.5-4.9 ppm	1.5-5.5 ppm	0.90-1.1 ppm			
Urine fluoride	0.4-8.6 ppm	0.7-7.2 ppm	0.2-1.5 ppm			
Serum fluoride	0.02-0.6 ppm	0.04-0.5 ppm	0.003-0.009 ppm			

Table 2: Levels of thyroid normones in an sample groups						
Parameters	Group 1A	Group 1 B	Group 2			
Free T 3	1.2-4.23 pg/ml	1.1-4.3 pg/ml	2.2-4.0 pg/ml			
Free T 4	0.7-1.82 ng/dL	1.0-6.2 ng/dL	1.0-1.7 ng/dL			
TSH	1.5-7.9μIU/m	2.4-10.8µIU/m	1.0-3.8µIU/m			

Table 2. Levels of thread hormones in all somely groups

The analysis of thyroid hormone levels (FT3, FT4, TSH) showed that abnormalities were present in 50% of cases within Group 1, while only 10% of children were affected in Group 2. Within Group 2, 40% of children displayed slightly elevated serum fluoride concentration, whereas in Group 1, this proportion was much higher at 90%. Children residing in endemic areas exhibited disturbances in serum thyroid hormone and TSH levels, accompanied by increased fluoride concentration in bodily fluids. This had an impact on tooth development, leading to delayed tooth eruption among children in endemic regions, but not among those in non-endemic regions. levels of thyroid

hormones (FT3 & FT4) and TSH in bodily fluids were measured for both Group 1A and 1B, as well as for the 10 children in Group 2. Among these measurements, the concentration of FT4 was found to be highest in Group 1A, whereas the levels of TSH were notably elevated in Group 1B. A study by Singh N e al, a sample group of 60 male and female school children, with or without dental fluorosis, consuming fluoride-contaminated water in endemic fluoride area of Udaipur district, Rajasthan were selected through a school dental fluorosis survey. The sample of 10 children of same age and socio-economic status residing in non endemic areas who did not have dental fluorosis form control.

Table 3: Derangement in Thyroid hormone	(FT ₃ ,	FT4,	TSH)	levels and	serum	fluoride	levels in	children
0	of diffe	erent	groups	5				

Group	Cases with deranged	Cases with abnormal	Delayed eruption
	thyroid hormone levels	fluoride levels	
Group 1 A	2 (40%)	4 (80%)	1 (20%)
Group 1B	3 (60%)	5 (100%)	2 (40%)

Group 2 1 (10%) 3 (30%) 0 (0%)				
	Group 2	1 (10%)	3 (30%)	0 (0%)

A significant correlation was found with values of TSH in different groups. Level of water, serum and urine fluoride was showing highly significant correlation with both group 1 & 2.

Parameters	Groups	Mean	P-value
TSH	1	3.5	0.04
	2	2.5	
Water fluoride	1	2.7	0.001
	2	0.9	
Urine fluoride	1	2.7	0.001
	2	0.5	
Serum fluoride	1	0.1	0.003
	2	0.02	

 Table 4: Correlation of various parameters with Group 1 and Group 2

Discussion

Fluoride and iodine are both halogens. The fluoride, the negative ion of the element fluorine easily displaces iodine in the body because it is much lighter and therefore more reactive. In fact the activity of any one of the halogens is inversely proportion to its atomic weight. In other words, one halogen can displace another one of a higher atomic weight but cannot displace one of lower weight thereby, results fluoride- thyroid-iodine antagonism which in turn lead to interference with iodine uptake. The fluoride is a universal G-protein activator/inhibitor. The stimulation of certain G-proteins occurs due to the toxic effects of fluoride, which has the effects of switching off the uptake into the cell of the active thyroid hormone. The thyroid control mechanism is compromised. The TSH output from pituitary gland is inhibited by fluoride, thus reducing thyroid output from thyroid glands. Fluoride competes for the receptor sites on the thyroid gland which respond to TSH; so that this hormone reaches the thyroid gland and so fewer hormone is manufactured. ^{1, 16} Hence, this study was collected to compare fluoride ingestion levels, disruptions in serum thyroid hormone and TSH levels, as well as the prevalence of dental fluorosis, was conducted among school children residing in regions affected and unaffected by fluorosis. In the present study, the levels of thyroid hormones (FT3 & FT4) and TSH in bodily fluids were measured for both Group 1A and 1B, as well as for the 10 children in Group 2. Among these measurements, the concentration of FT4 was found to be highest in Group 1A, whereas the levels of TSH were notably elevated in Group 1B. A study by Singh N e al, a sample group of 60 male and female school children, with or without dental fluorosis, consuming fluoride-contaminated water in endemic fluoride area of Udaipur district, Rajasthan were selected through a school dental fluorosis survey. The sample of 10 children of same age and socio-economic status residing in non endemic areas who did not have dental fluorosis form controls. The significantly altered FT3, FT4 and TSH hormones level in both group1A and 1B school children were noted. The serum and urine fluoride levels were found to be increased in both the groups. A significant relationship of water fluoride to urine and serum fluoride concentration was seen. The serum fluoride concentration also had significant relationship with thyroid hormone (FT3/FT4) and TSH concentrations. The testing of drinking water and body fluids for fluoride content, along with FT3, FT4, and TSH in children with dental fluorosis is desirable for recognizing underlying thyroid derangements and its impact on fluorosis. 17 In the present study, the analysis of thyroid hormone levels (FT3, FT4, TSH) showed that abnormalities were present in 50% of cases within Group 1, while only 10% of children were affected in Group 2. Within Group 2, 40% of children displayed slightly elevated serum fluoride concentration, whereas in Group 1, this proportion was much higher at 90%. Children residing in endemic areas exhibited disturbances in serum thyroid hormone and TSH levels, accompanied by increased fluoride concentration in bodily fluids. This had an impact on tooth development, leading to delayed tooth eruption among children in endemic regions, but not among those in non-endemic regions. Another study by Zulfigar et al, examined 134 children were studied for comparison and correlation between an endemic fluorotic village Rukh Mudke (RM), n = 74, and a non-fluorotic village Ottawa (OTW), n = 60. The children were aged between 7-18 years and selected for the estimation of fluoride in their household water, body fluids (urine-serum), dental fluorosis and thyroid hormones (Free triiodothyronine (FT3) free tetra iodothyronine (FT4) and thyroid stimulating hormone (TSH) respectively. Mean concentration of water fluoride in subjects of RM was 4.6 ×106 ng/L, urine fluoride 2.59 ×106 ng/L, serum fluoride 6.0 ×104 and dental fluorosis 90.5% respectively. Significant elevation (P = 0.000) in the concentration of three out of these four variables (P < 0.01) was observed (except in serum fluoride) in subjects of RM compared to those in the control group (OTW). Mean FT4, FT3 and TSH concentrations in RM subjects was 18.3 pmol/L, 5.06 pmol/L and 3.2 mlU/L respectively. No marked difference in FT4 and FT3 (P = 0.17 and P = 0.7) was found compared to the control (OTW) group, while significant elevation in TSH (P < 0.05) was found in. 22% of the children in the RM group, portrayed well defined thyroid hormonal aberrations. A negative correlation between water fluoride - FT4 (r = -0.24); a strong positive between water, urine, serum, dental fluorosis and TSH (r = 0.94, 0.87, 0.88, 0.74 and 0.8) and moderate correlation between water fluoride -FT3 (r = 0.52) was observed. Results of this study indicate that the fluoride intoxication through drinking water is not only increasing fluoride level in body fluids and deteriorating teeth but also destroying thyroid function in a large number of children.¹⁸ Shaik N et al, for serum TSH levels 40% of children of group I had deranged levels followed by group III (20%) and Group II (16%). For serum T4 levels 24% of children of both groups I and III had deranged levels followed by group II (20%). Inter group correlation of drinking water fluoride levels to number of deranged serum T3, T4, and TSH of the children showed non-significant association. The long term intake of fluoridated drinking water (0.02 -1.4 ppm) did not showed effect on the thyroid function in the children with normal nutritional status and optimal iodine intake. 19

Conclusion

Children residing in endemic fluorosis areas who exhibit dental fluorosis might not necessarily develop thyroid diseases as a direct result of excessive fluoride consumption. However, they do display thyroid-related issues that can have significant health implications. Consequently, these children necessitate specialized care and attention. S. A comparative study of fluoride ingestion levels, serum thyroid hormone & TSH level derangements, dental fluorosis status among school children from endemic

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