

PREVALENCE OF DENTAL FLUOROSIS AND FLUORIDE CONTENT OF DRINKING WATER IN RURAL AREAS OF MALAPPURAM DISTRICT, KERALA

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ABSTRACT

Background: Dental fluorosis which manifests as discoloration of teeth is an aesthetic problem usually encountered. If the intake of fluoride in the formative years is excessive it may lead to dental and skeletal fluorosis. While optimum fluoride is beneficial for the dental tissues affording better caries resistance, the excess intake leads to defective enamel and skeletal development.

Aims & Objective: The objective of this study was to detect the fluorosis cases in rural areas of malappuram district in Kerala and correlate this with the level of fluoride in the water used for consumption and decide whether defluoridation of these water sources are needed.

Material and Methods: Cases of fluorosis were detected and water from their drinking sources were collected in sterile plastic containers and fluoride level was estimated by ion selective exchange method.

Results: The clinical cases of fluorosis graded from 0.5 to 4 according to Dean's fluorosis index. Only a few samples showed the presence of fluoride and that too in trace amounts.

Conclusion: The results of our study fail to show an association between the clinically evident dental fluorosis and the fluoride levels in the drinking water sources. This does not negate the well proven fact the fluorosis is caused by intake of fluoride in excess amounts during the formative years. We conclude that the excess intake must have been due to supplementation from dietary sources, toothpastes or from any other sources. It may also be due to the air borne fluorides or defective fluoride metabolism due to any drug intake.

Key-Words: Dental Fluorosis; Fluoride; Drinking Water

Introduction

Fluoride is of interest to the medical fraternity as the deficiency of the element fluoride has been associated with defective enamel formation in teeth and the excess has been associated with skeletal and dental fluorosis. Hence it is important that the fluoride consumption be kept to an optimum for proper development of the calcified tissues. In our experience we have come across many cases of intrinsic pigmentation of teeth clinically resembling dental fluorosis in Malappuram district of Kerala. The study was intended to detect if there was any excess in fluoride in the drinking water used by the people living in this particular area.

Fluoride is a chemical element that is found most frequently in groundwater due to weathering and leaching of fluoride-bearing minerals from rocks and sediments. It is not produced in human body. Fluoride accounts for about 0.3gm/kg of earth's crust. Being highly reactive, it is never found in its elemental gaseous form, but only in combined form. About 96% of the fluoride is found in bones and teeth.^[1] When ingested in small quantities (<0.5 mg/L or 0.7ppm) fluoride is beneficial for teeth by reducing dental caries, whereas ingestion of higher concentrations (>1.5 mg/L) may cause fluorosis. Dental

fluorosis manifests as opaque white spots or lines, and in severe cases, enamel becomes discolored and brittle, leading to chipping.^[2,3] The Bureau of Indian Standards (BIS) has set the maximum permissible level of fluoride in drinking water at 1 ppm.^[4] Dr. Fredrick McKay in Colorado Springs, Colorado, USA, noticed that many of his patients, particularly those who lived there all their life, had an apparently permanent stain on their teeth, which was known as 'Colorado stains'. He called the stains mottled enamel. In 1931, the element fluoride was identified as the "mysterious factor" responsible for mottled enamel. T.H. Dean reported that high concentration of fluoride in water is directly proportional to the severity of enamel mottling. Dean in 1934 developed a standard system for classification of dental fluorosis, "The Mottling Index".^[1] Shearer and co-workers in 1980 in their work on micro hardness of enamel reported that fluorosis, along with discoloration caused weakness of enamel.^[5] Sierant and Bartlett in 2012 reported that stresses encountered during the dental developmental ages could produce lasting effects on the appearance of enamel.^[6]

Exposure to fluoride from drinking water depends greatly on natural circumstances. Levels in raw water are normally below 1.5mg/L but ground water may contain about 10 mg/L in areas rich in fluoride containing

minerals. Fluoride exposure in humans is determined by fluoride concentration in drinking water, duration of consumption, and climate of the area.^[3] Researches have shown that there are 4 sources that increase the risk for dental fluorosis namely: fluoridated drinking water, fluoride supplements, topical fluoride (especially fluoride toothpastes), and formula prescribed for children. Furthermore, some children's industrialized food may also increase the cumulative fluoride intake.^[7] Sarvaiya and co-workers found a very strong correlation between fluorosis index and fluoride levels in drinking water in their study on school children in Rajasthan in 2012.^[8] Firempong and co-workers (2013) conducted a study on fluorosis and water fluoride levels in Ghana and found a positive correlation between the two.^[9] Inorganic fluorine compounds are used in the production of aluminium and fluoride is released during the manufacture and use of phosphate fertilizers which contain up to 4% fluorine. Levels of daily exposure of fluoride depend on the geographical area.

The principle sources of fluoride to man are, (1) Drinking water is the major source of fluoride. In most parts of India, the fluoride content of drinking water is 0.5 mg/L, but in fluorosis endemic areas, it may be as high as 3-12 mg/L. (2) Fluoride occurs in traces in many food items, but some items such as sea fish, cheese and tea are reported to be rich in fluoride. In specific areas, other food items and indoor air pollution may contribute considerably to total exposure. Additional intake may result from the use of fluoridated tooth paste.

The aim of the study is to identify and quantify the level of fluorosis in the community residing in rural areas of Malappuram district, Kerala. To analyze the fluoride content in the water samples collected from sources used for consumption by people exhibiting clinical signs of fluorosis and to correlate the above results and decide if defluoridation is needed for the water from these sources.

Materials and Methods

IEC approval was obtained after submitting the proforma and informed consent form. The study was conducted in rural areas of Malappuram district, Kerala. The investigators identified 52 cases exhibiting signs of dental fluorosis from among patients visiting the OPD of Educare Institute of Dental Sciences, Malappuram within a time span of 3 months and collected water samples from the water sources they used for consumption. Informed consent was obtained from the subjects before dental examination using a sterilized mouth mirror and explorer. The

fluorosis was quantitated as per Dean's fluorosis index. The proforma was duly completed. Water (100 ml from each source) was collected in plastic bottles and transported to CWRDM (Center for Water Resources Development and Management) for fluoride level analysis using ion- selective electrode method. The results were compared to find if there was any correlation between the levels of fluorosis and the fluoride level in the drinking water.



Figure-1: Patient with Fluorosis



Figure-2: Plastic Containers to Collect Water

Results

Even though 37 subjects showed moderate to severe fluorosis, water investigation failed to show presence of fluoride in excess. Only 4 samples showed the presence of fluoride that too in trace amounts. (Table 1).

Discussion

Fluoride is called "double edged sword". Kanagaratnam et al reported that, reticulated water fluoridation decreased the incidence of caries in children, and it was also found that some opacities developed in some cases.^[10] The risk of the development of dental or skeletal fluorosis increases at doses higher than 0.7 ppm. Dental fluorosis is the result of excess fluoride during enamel development, which for the permanent teeth occurs in childhood between the ages of 2 to 8 years old. Prolonged ingestion of fluorine through drinking water in excess of daily requirement is associated with dental and skeletal fluorosis.

Table-1: Patients with Fluorosis

Sample No.	Age	Dean's Fluorosis Index of the subjects examined	Fluoride content in the sample (mg/L)
1	15	0.5	Not Detected
2	23	1	Not Detected
3	26	3	Not Detected
4	18	2	0.067
5	20	3	Not Detected
6	26	4	Not Detected
7	28	2	Not Detected
8	35	1	Not Detected
9	29	2	Not Detected
10	21	4	Not Detected
11	20	3	Not Detected
12	31	4	Not Detected
13	17	1	Not Detected
14	20	4	Not Detected
15	25	2	Not Detected
16	32	1	Not Detected
17	26	0	Not Detected
18	40	3	Not Detected
19	25	3	Not Detected
20	20	4	0.15
21	26	1	Not Detected
22	19	4	Not Detected
23	28	2	Not Detected
24	22	1	Not Detected
25	20	3	Not Detected
26	34	2	Not Detected
27	30	3	0.024
28	24	2	Not Detected
29	26	2	Not Detected
30	28	3	Not Detected
31	35	1	Not Detected
32	20	4	Not Detected
33	19	0.5	Not Detected
34	36	4	0.45
35	22	1	Not Detected
36	27	2	Not Detected
37	35	2	Not Detected
38	21	2	Not Detected
39	20	3	Not Detected
40	26	1	Not Detected
41	34	1	Not Detected
42	20	4	Not Detected
43	18	2	Not Detected
44	29	3	Not Detected
45	23	3	Not Detected
46	30	1	Not Detected
47	25	4	Not Detected
48	26	4	Not Detected
49	29	2	Not Detected
50	21	2	Not Detected
51	34	1	Not Detected
52	26	3	Not Detected

In this study we have definitely found clinical signs suggesting dental fluorosis. We failed to find any correlation between the fluoride content in the water procured from the drinking sources and the degree of fluorosis present which is consistent with the findings of Azami-Aghdash and co-workers^[11] and the HongKong based study by Wong and co-workers^[12]. An Indian study of Mythri et al in Karnataka is reported similar findings. They attributed this to lack of proper planning and implementation of the defluoridation projects.^[13] These

finding are in contrast to the reports by Sarvaiya and co-workers.^[8]

Smith in 1988 noted that dental caries was declining even in people consuming un-fluoridated water and may be attributed due to sources in the environment such as fertilizers and solid wastes containing fluoride. He also claimed that fluoride containing dental health products might contribute to this excess intake of fluoride.^[14] Marier reports the inadequate dietary intakes nutrients like of calcium and vitamin C may accumulate fluoride, and even leads to chronic fluoride intoxication.^[15] Denbesten^[16] reported that ionic fluoride in high concentrations have been found in vegetables, fruits, tea and other crops in addition to ground waters in many parts of southern Asia, namely India and Sri Lanka. The atmosphere in these areas also was speculated to have high levels of fluoride released from volcanic activities or industries. Khan et al^[17] reported fluorosis even with 0.35 ppm of fluoride in water and they have considered, the dietary habits, other possible fluoride exposure while determining the optimum fluoride level in the drinking water. It is possible that ingestion of atmospheric fluoride may add to the total fluoride ingestion. The heat and humidity of the area also promotes increased consumption of water, which might increase the net daily intake of fluoride.

Zohoori et al^[18] noted that the fluoride intake from dentifrices varied in children with the amount of paste used, fluoride concentration in the dentifrice and the age of the child. Levy et al^[19] in his study among American children reported that there were chances of mild fluorosis in children who ingested large amounts of fluoride from reconstituted concentrate infant formulas and fluoridated dentifrice.^[20] A study in Japan by Nohno et al evaluated the fluoride concentration in different infant formulas and reported as within normal limits. They raised the doubt that the level may exceed the optimum when reconstituted with water.^[21] Do and co-workers found that fluorosis was more prevalent in children who were given infant formulas even when the traditional home prepared infant formulas were used.^[22]

Sarvaiya et al^[8] had also reported that that the fluoride content in the water supplies are affected by climatic variations. It has been reported that fluoride content increases after a drought and decreases after heavy rains. For the dental fluorosis to have manifested the subjects would have ingested the higher amounts of fluoride during their developing years, which on an average was 20 to 25 years back. There is chance that the fluoride content in the water sources might have got depleted with time.

According to Pindborg enamel defects of non-fluoride nature can be caused local agents and systemic conditions. The intake of drugs like tetracycline causes yellowish brown staining of teeth.^[23] Hong and co-workers have quoted that children treated with amoxicillin in the early ages are at risk of developing dental fluorosis of later developing zones.^[24] Ciarrocchi et al also raised similar doubts but failed to identify the causative effect of amoxicillin.^[25] Amoxicillin is a widely used drug for control of infections in this part of the country. We would like to suggest that further studies regarding this possibility should be explored as this might very well be a risk factor in the development of fluorosis in the area.

Conclusion

The study tried to find the correlation between the fluorosis and the fluoride levels in the drinking water in the area. Even though the results of the present study fail to show any positive correlation between the fluoride content in water and the levels of fluorosis, we do not negate the well documented fact that fluorosis is caused by ingestion of high levels of fluoride. Further studies to assess the serum fluoride level might help to know if the fluoride consumption is still high and if so, may point to some other source than the water or infant formulas. A prospective study taking into account other variables like drug intakes, artificial feeding formulas and use of fluoridated dentifrice will help to throw light on the development of fluorosis in these areas. The remedial measures should be planned according to the results of further studies. All factors other than environmental contributing to this condition can be controlled by patient education and systematic monitoring. Environmental exposure will require that the regulatory authorities be informed and required to intervene to contain the problem.

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