Prevalence of Dental Fluorosis in Children from Fluorosis-endemic Areas

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Abstract: Objective. To study the prevalence of dental fluorosis in children and its possible relationship with fluoride intake by drinking water. **Methods.** 198 children aged 8 – 12 years old were allocated into 2 groups (A and B) according to the water fluoride levels. Dental fluorosis was examined by Dean's method and CFI was calculated. The children's urinary samples were collected. Ion-selective electrode method was used to determine the fluoride concentration in drinking water and urinary samples. **Results.** The significant differences were found between two groups in children urinary fluoride levels (0.62 mg/L and 1.49 mg/L) and the prevalent incidence of dental fluorosis (13.51% and 43.68%) ($P<0.01$). There were significant correlations between dental fluorosis and fluoride level in drinking water, dental fluorosis and fluoride level in urine respectively ($\chi^2 = 21.73, P<0.005$). **Conclusion.** For the fluoride level of 1.22 mg/L in drinking water, dental fluorosis should be closely monitored. The urinary fluoride level of children may be an effective index. [Life Science Journal. 2006;3(4):57 – 60] (ISSN: 1097 – 8135).

Keywords: water fluoride; urinary fluoride; dental fluorosis

Abbreviations: CFI: community fluorosis index

1 Introduction

Over fluoride intake during the formative years of a child's enamel development can cause dental fluorosis which is often a condition marked by permanent staining of adult teeth. The discoloration induced by dental fluorosis, particularly in its advanced forms, can cause significant embarrassment and stress to the impacted child, resulting in adverse effects on esteem, emotional health, and career success. In drinking-water type of fluorosis-endemic areas, drinking water is a main exposure pathway contributing to endemic fluorosis. Although the engineer of altering water sources to lower fluoride in drinking water prevents endemic fluorosis effectively, especially for skeletal fluorosis, the fluctuations in the fluoride concentration in the drinking water and its effect on dental fluorosis are still worth concerning[1, 2]. Even with the low fluoride concentration in drinking water of 0.872 mg/L, cases of mild dental fluorosis in 12-year-old children were observed[3]. In present study, two villages were chosen from Neihuang town in Henan province, a fluorosis-endemic area caused by high fluoride concentration in ground water, to investigate the prevalence of dental fluorosis in children and its possible associations with the fluoride concentrations in drinking water and children's urinary.

2 Materials and Methods

2.1 Villages investigated

The geographical condition, climatic condition, economic development, population, variety of crop and custom are similar in two chosen villages marked as group A and group B, respectively. There is no industrial pollution of fluoride in both villages where ground water is the only source of drinking water.

2.2 Fluoride level in water and children's urine

Five water samples from the east, west, south, north, and middle locations of each village were collected representing the water quality of the whole village. Stratified sampling method was used in collecting the spot urine samples of school going children aged 8 – 12 years old. The urine samples were collected in nonreactive plastic containers and brought to the laboratory within 4 hours. A total of 10 water samples and 100 urine samples from two villages were collected and analyzed by iron-selective electrode method. Total ionic strength adjustment buffer made from sodium citrate, acetic acid and sodium chloride, was added to the standard fluoride solutions as well as the samples before measurement of fluoride. The instrument was calibrated with two standard solutions so that the concentration of one was 10 times of the other and also that the concentration of the unknown falls between those two standards. Then, the concentration of the unknown was directly read from the digital display of the meter.

2.3 Assessment of dental fluorosis

All the children in the two villages were assessed for dental fluorosis according to Dean's classification. All the examiners were trained. Normal is the station that the enamel represents the usual translucent semivitriform type of structure. The surface is smooth, glossy, and usually pale creamy white color. Questionable means that the enamel discloses slight aberrations from the translucency of normal enamel, ranging from a few white flecks to occasional white spots. This classification is utilized in those instances where a definite diagnosis of the mildest form of fluorosis is not warranted and a classification of "normal" is not justified. Very mild is small opaque, paper white areas scattered irregularly over the tooth but not involving as much as 25% of the tooth surface. Frequently included in this classification are teeth showing no more than about 1 – 2 mm of white opacity at the tip of the summit of the cusps of the bicuspids or second molars. Mild is the station that the white opaque areas in the enamel of the teeth are more extensive but do not involve as much as 50% of the tooth. Moderate means that all enamel surfaces of the teeth are affected, and the surfaces subject to attrition show wear. Brown stain is frequently a disfiguring feature. Severe includes teeth formerly classified as "moderately severe and severe." All enamel surfaces are affected and hypoplasia is so marked that the general form of the tooth may be affected. The major diagnostic sign of this classification is discrete or confluent pitting. Brown stains are widespread and teeth often present a corroded-like appearance.

The prevalence of dental fluorosis and community fluorosis index (CFI) were calculated. CFI was calculated based on the symptoms classifications of dental fluorosis, viz., normal, questionable, very mild, mild, moderate, moderately severe and severe. The number of children in each category was multiplied by the corresponding numerical weight, the products thus obtained for the various categories were added up and the total sum was divided by the total number of people surveyed, giving the community fluorosis index.

2.4 Statistical analysis

The statistical analysis was performed by t-test and Chi-square tests with a 5% significance level.

3 Rusults

3.1 Level of fluoride in water samples

In the village A, the fluoride distribution of water samples ranged from 0.15 mg/L to 0.13 mg/L. The mean value of fluoride was 0.14 mg/L and the standard deviation was 0.01 mg/L. While in the village B, the fluoride concentration in water samples ranged from 1.81 mg/L to 0.66 mg/L. The mean value of fluoride and the standard deviation were 1.22 mg/L and 0.56 mg/L, respectively.

3.2 Level of fluoride in urine samples

The data on fluoride distribution in urine samples in children have been given in Table 1. The significant difference was found between the two villages children's urinary fluoride levels ($P < 0.01$).

Table 1. The level of fluoride in urine of children (mg/L)

Group	Cases (n)	Fluoride ($\bar{x} \pm s$)
A	50	0.62 ± 0.54
B	50	1.49 ± 0.79

t-test, $t = -6.45$, $P < 0.005$

3.3 Dental fluorosis

The results of percentage incidence of dental fluorosis and CFI obtained for both groups were given in Table 2. There was significant difference in prevalence of dental fluorosis between two villages' children ($P < 0.01$). The predominant category of dental fluorosis in group A and group B was very mild (12.6% and 32.2%), followed by questionable (12.6% and 16.1%), mild (0.9% and 8.0%), moderate (0% and 2.3%), and severe (0% and 1.5%) (Table 3).

Table 2. Percentage of dental fluorosis and Dean's Index in children

Group	Cases(n)	Positive cases(n)	Prevalence(%)	CFI
A	111	15	13.51	0.22
B	87	38	43.68	0.68

Chi-square test, $\chi^2 = 22.46$, $P < 0.005$.

3.4 Correlations of dental fluorosis, fluoride level in drinking water and in urine

Significant correlation was found between stages of dental fluorosis and fluoride levels in drinking water. There was also a significant correlations between dental fluorosis and fluoride level in urine (Table 3).

Table 3. Correlations between dental fluorosis and fluoride in water, fluoride in urine

Group	Fluoride in water (mg/L)	Fluoride in urine (mg/L)	Stage of dental fluorosis (n)					
			normal	questionable	very mild	mild	moderate	severe
A	0.14	0.62	82	14	14	1	0	0
B	1.22	1.49	35	14	28	7	2	1

Stage of dental fluorosis *vs*. fluoride level in water, $\chi^2 = 21.73$, $P < 0.005$
Stage of dental fluorosis *vs*. fluoride level in urine, $\chi^2 = 21.73$, $P < 0.005$

4 Discussion

High amounts of fluorides in drinking water is the common reason resulting in dental fluorosis. Positive correlation was found between fluoride concentrations in groundwater and occurrence of dental fluorosis in several studies[4,5]. On the other hand, there are many people in the world such as in US receiving drinking water from municipalities that add fluoride to their water systems to prevent dental carries. Some researches have shown carries reduction of up to 40% after fluoridation[6,7]. Although the efficacy of drinking-water fluoridation is well accepted by the policy makers, the benefits are not without consequence. Children from a fluoridated community in Republic of Ireland showed a prevalence of 36% with dental fluorosis[8]. People have paid more attention on the low fluoride level in drinking water with low caries but prevalence of dental fluorosis in children[9].

Both of the two villages investigated are from endemic fluorosis area where altering water sources to lower the fluoride level has been taken to control the endemic fluorosis for more than 10 years. However, the prevalence of dental fluorosis can be affected by the low fluoride concentration less than 1 mg/L in the drinking water[10]. As shown in Table 2, the prevalence of dental fluorosis was significantly lower in the group of children drinking water with 0.14 mg/L fluoride as compared to the group of children drinking water with 1.22 mg/L fluoride. For the more, the stages of children's dental fluorosis tended to become more severe with the rising of fluoride concentration in drinking water (Table 3).

When the CFI value is higher than 0.6, fluorosis is considered to be a public health problem in that area. Although the CFI in both groups were lower than 1.0 (medium public health significance of fluorosis), there were still 13.5% dental fluorosis (mostly very mild to mild) caused by the drinking water with fluoride level of 0.14 mg/L. As for the drinking water with fluoride level of 1.22 mg/L, slightly above optimum levels of exposure recommended by WHO (1.0 mg/L), the prevalence of dental fluorosis was 43.68% and severe case was observed (Table 3). Therefore, it would be necessary to keep close monitoring of the fluoride concentration in drinking water and dental fluorosis in the children of right age in this area.

Besides fluoride in drinking water, there are other sources of fluoride that contribute to overall fluoride intake and therefore may contribute to dental fluorosis, such as fluoride toothpaste, food grown in soil containing fluoride or other uncertain source[11]. When assessing the levels of fluoride ingestion, it's difficult to determine the fluoride intake from all potential sources. As urine is the main excretion route for ingested fluoride, and when persons have taken fluoride for a long time and have reached a steady state of balance, they ultimately excrete via urine every day an amount of fluoride essentially equivalent to the amount consumed, so fluoride concentration in urine has a direct relation with intake of fluoride iron and can be an index of total exposure. 24-hour urinary fluoride excretion and the fractional urinary fluoride excretion were used to estimate the total fluoride intake in some studies[12, 13]. The 24-hour urinary fluoride excretion and the fractional urinary fluoride excretion are more reliable than spot sample. Although large variations were observed in the individual urinary fluoride levels, which may be the result of different age, eating and drinking habit, urine pH, urine flow rate, kidney status, and other factors, analysis of spot fluoride concentration in urine is a useful way to estimate the overall fluoride intake of population[14]. In this study, it's reported that as the degree of dental fluorosis increased from normal to severe, the level of spot urinary fluoride excretion was increased. It's suggested that spot sample of urinary fluoride excretion can be used as an indicator for monitoring the dental fluorosis risk when it is not feasible to obtain reliable 24-hour urinary samples.

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