



RESEARCH ARTICLE

EFFECTS OF FLUOROSIS AND ITS PREVENTION: REVIEW

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ABSTRACT

Fluoride contamination in drinking water has been documented as one of the major problems worldwide which is a serious threat to human health. Prolonged ingestion of fluoride through drinking water in excess of the daily requirement is associated with dental and skeletal Fluorosis. The WHO and BIS has decided fluoride concentration up to 1-1.5 mg/L as a permissible limit for drinking. The concentration of fluoride in the level of 1.5-4mg/L results in dental fluorosis whereas prolonged consumption at still higher fluoride concentrations (4-10mg/L) will cause dental fluorosis and skeletal fluorosis. This review article is aimed at providing precise information about fluorosis, its ill effects and prevention in INDIA.

INTRODUCTION

Fluorine is the most abundant element in nature, and about 96% of fluoride in the human body is found in bones and teeth. Fluorine is needed for the normal mineralisation of bones and formation of dental enamel. The main source of fluorine is drinking water and food such as sea fish, cheese and tea. The recommended level of fluoride in drinking water in India is 0.5 to 0.8 mg/l. Fluorosis is an important public health problem in 24 countries, including India, which lies in the geographical fluoride belt. Of the 85 million tons of fluoride deposits on the earth's crust, 12 million are found in India. Hence it is natural that fluoride contamination is widespread, intensive and alarming in India. The available data suggest that 15 States in India are endemic for fluorosis (fluoride level in drinking water >1.5mg/l), and about 62 million people in India suffer from dental, skeletal and non-skeletal fluorosis. Groundwater is considered as the major source of drinking water in most places on earth. India was one of the worst fluorosis affected countries, with large number of people suffering. The reason behind this is that Indians rely on groundwater for drinking purposes and water at many places is rich in fluoride. World Health Organization (WHO) has set the upper limit of fluoride concentration in drinking water at 1.5 mg/l and The Bureau of Indian Standards (BIS), has therefore, laid down Indian standards as 1.0 mg/l as maximum permissible limit of fluoride

with further remarks as "lesser the better". Intake of fluoride higher than the optimum level is the main reason for dental and skeletal fluorosis. Fluorine is often called as two-edged sword. Prolonged ingestion of fluoride through drinking water in excess of the daily requirement is associated with dental and skeletal Fluorosis. Similarly, inadequate intake of fluoride in drinking water is associated with dental caries.

MATERIALS AND METHODS

Dental Fluorosis

Tooth enamel is principally made up of hydroxyapatite (87%) which is crystalline calcium phosphate. Fluorosis of dental enamel occurs when excess fluoride is ingested during the years of tooth calcification-essentially during the first 7 years of life. It is characterised by mottling of dental enamel. On prolonged continuation, the teeth become hard and brittle. This is called dental fluorosis. Dental fluorosis in the initial stages results in the tooth becoming coloured from yellow to brown to black. Depending upon the severity, it may be only discolouration of the teeth or formation of pits in the teeth. The colouration on the teeth may be in the form of spots or as streak.

Classification of Dental Fluorosis

Dean described the grades of endemic mottled enamel, which were associated with varying levels of fluoride in the drinking

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water. The classification was based upon the degree of severity of the defects.

- **Normal enamel:** The enamel is translucent, smooth and presents a glossy appearance.
- **Questionable mottling:** Normal enamel, but translucency is varied by a few white flecks or white spots.
- **Very mild mottling:** Small, opaque, paper white areas are scattered over the teeth, involving less than 25 percent of the tooth surface. Summits of the cusps of bicuspids and second molars are commonly affected.
- **Mild mottling:** The white opaque areas are more extensive but do not involve more than 50 percent of the surface and faint brown stains are sometimes apparent.
- **Moderate mottling:** All enamel surfaces are affected and those which are subjected to attrition, show marked wear. Brown stain is a frequent disfiguring feature.
- **Severe mottling:** Severe hypoplasia affects the form of the tooth. Stains are wide spread and vary in intensity from deep brown to black and the teeth often present a corroded appearance.

Diagnosis of Dental Fluorosis

Indices Used To Diagnose Dental Fluorosis

Fluoride opacities are distinct. Trace elements other than fluoride, like strontium and zinc have shown an association with fluorosis like opacities, but these associations were found to be weak. Two distinct groups of indexes have been proposed for measuring dental fluorosis.

Specific fluorosis indexes: Specifically measures the fluoride induced enamel changes in order to reflect increasing severity of fluorosis of lesions.

Descriptive indexes: It includes all defects of enamel and are recorded based solely on descriptive criteria, regardless of causative factors. It is based on the principle that examiner should record what he sees and do not presume the etiology.

Dean's Index

Dean provided a standard classification system for clinical conditions as described by McKay on 2000 subjects in endemic areas of six states in USA.

Table 1. Diagnostic criteria and weighting system for Dean's Index

Classification and weight	Original criteria (dean, 1934)	Modified criteria (dean, 1942)
Normal 0	The enamel presents the usual translucent semivitriform type of structure. The surface is smooth and glossy and usually of a pale creamy white color.	The enamel presents the usual translucent semivitriform type of structure. The surface is smooth, glossy and usually of a pale creamy white color.
Questionable 0.5	Slight aberrations in the translucency of normal enamel, ranging from a few white flecks to occasional white spots, 1 to 2 mm in diameter	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" not justified.
Very Mild 1.0	Small, opaque, paper-white areas are scattered irregularly or streaked over the tooth surface. It is principally observed on the labial and buccal surfaces, and involves less than 25% of the tooth surfaces of the particular teeth affected. Small pitted white areas are frequently found on the summits of the cusps. No brown stain is present in the mottled enamel of this classification.	Small, opaque, paper-white areas scattered irregularly over the tooth but not involving as much as approximately 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 tips of the summits of the cusps of the bicuspids or second molars.
Mild 2.0	The white, opaque areas on the surfaces of the teeth involve at least half of the tooth surface. The surfaces of molars, bicuspids, and cuspids subject to attrition show thin white layers worn off and the bluish shades of underlying normal enamel. Faint brown stains are sometimes apparent, generally on the upper incisors.	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 3.0	No change is observed in the form of the tooth, but generally all of the tooth surfaces are involved. Surfaces subject to attrition are definitely marked. Minute pitting is often present, generally on the labial and buccal surfaces. Brown stain is frequently a disfiguring complication. It must be remembered that the incidence of brown stain varies greatly in different endemic areas, and many cases of white opaque mottled enamel, without brown stain, are classified as "moderate" and listed in this category.	All enamel surfaces of the teeth are affected, and surfaces subject to attrition show marked wear. Brown stain is frequently a disfiguring feature.
Moderately Severe	Macroscopically, a greater depth of enamel appears to be involved. A smoky white appearance is often noted. Pitting is more frequent and generally observed on all the tooth surfaces. Brown stain, if present, is generally deeper in hue and involves more of the affected tooth surfaces.	
Severe 4.0	The hypoplasia is so marked that the form of the teeth is at times affected, the condition often being manifest in older children as a mild pathologic incisal occlusal abrasion. The pits are deeper and often confluent. Stains are widespread and range from a chocolate brown to almost black in some cases	It 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 maybe affected. The major diagnostic sign of this classification is the discrete or confluent pitting. Brown stains are widespread and teeth often present a corroded like appearance.

The “moderately severe” and the “severe” categories were combined into a single “severe” category providing the six-point measurement ordinal scale.

Shortcoming of Dean’s Index

- Single score is given to a tooth rather than, a separate score to each tooth surface. Hence differences in the severity of fluorosis in different tooth surfaces cannot be ascertained.
- An individual has been classified according to the tooth most affected by fluorosis which may be located in the mouth that has little cosmetic value.
- Questionable diagnostic category (score 0.5) in Dean’s Index is difficult to define and interpret precisely.
- The distinctions between some of the diagnostic categories in Dean’s system are unclear, imprecise or lack sensitivity.

Skeletal Fluorosis

Exposure to very high fluoride over a prolonged period of time results in acute to chronic skeletal fluorosis. It was stated in 1993 that crippling skeletal fluorosis might occur in people who have ingested 10 to 20 mg of fluoride per day for over 10 to 20 years. Early stages of skeletal fluorosis start with pain in bones and joints, muscle weakness, sporadic pain, stiffness of joints and chronic fatigue. During later stages, calcification of the bones takes place, osteoporosis in long bones, and symptoms of osteosclerosis where the bones become denser and develop abnormal crystalline structure. In the advanced stage the bones and joints become completely weak and moving them is difficult. The vertebrae in the spine fuse together and the patient is left crippled which is the final stage. Skeletal fluorosis is usually not recognized until the disease reaches an advanced stage.

National Prevalence

- 70-100% districts are affected in Andhra Pradesh, Gujarat and Rajasthan.
- 40-70% districts are affected in Bihar, National Capital Territory of Delhi, Haryana, Jharkhand, Karnataka, Maharashtra, Madhya Pradesh, Orissa, Tamil Nadu and Uttar Pradesh
- 10-40% districts are affected in Assam, Jammu & Kashmir, Kerala, Chattisgarh and West Bengal. While the endemicity for the rest of the states is not known.

Prevention and Control of Fluorosis

Rajasthan and Gujarat in North India and Andhra in South India are worst affected. Punjab, Haryana, Madhya Pradesh and Maharashtra are moderately affected states in India, while the states Tamil Nadu, West Bengal, Uttar Pradesh, Bihar and Assam are mildly affected. Since, the fluorosis is irreversible; its prevention is the appropriate, using various intervention measures. Fluoride poisoning can be prevented or minimized by using alternative water sources, by removing excessive fluoride from drinking water, and by improving the nutritional status of populations at risk. The simple interventions include provision of surface water, rainwater and consumption of Low-fluoride groundwater. Other interventions are defluoridation of water through flocculation and adsorption. Similarly, health education and better nutrition are the some of the cost-effective intervention measures.

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