

Dental Fluorosis

Prevent Damage to Your Teeth

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THE action of fluoride ions in humans is a typical example of a double-edged sword. Fluoride is beneficial in small amounts but larger quantities lead to toxicity. Daily optimum level of fluoride consumption plays an important role in preventing dental caries and enhances the mineral deposition in bone. But fluoride beyond the threshold concentration can cause toxicity. Prolonged and excessive consumption of fluoride in various forms leads to deleterious effects on teeth (dental fluorosis), bone (skeletal fluorosis), and soft tissue (non-skeletal fluorosis).

In the early 1900s, brown mottled enamel was observed by Dr Fredrick McKay as a clinical effect of fluoride in Colorado. The stains were known as the 'Colorado stains' by local inhabitants. Dr Fredrick McKay further investigated and named these stains 'Mottled enamel.'

Around the 1920s, Dr Henry Klein found that enamel readily adsorbed fluoride. And so, individuals born in fluoridated environments developed teeth with greater resistance to caries compared to those exposed to fluoride after the eruption.

Research also showed that the presence of fluoride at certain levels in the water supply (1 part per million) resulted in minimum mottling and significantly lower prevalence of dental caries than that experienced in populations not exposed to fluoridated water supply. Hence, the optimal fluoride level recommended by the American Dental Association (ADA) for drinking water is 0.7-1.2 ppm.

Fluoride consumption beyond this recommended level leads to a condition known as dental fluorosis. It is a fluoride-induced condition in which enamel development is disrupted. It is observed as white spots or opaque white lines. When the fluoride intake is moderate, brown stains are seen, and at higher concentrations, discrete pitting of the enamel surface is seen.

The risk of fluorosis is greatest in the permanent maxillary incisors if the child is exposed to excessive levels of fluoride between the ages of 20 to 30 months old. Fluorosis in milk teeth is usually seen in the molars, particularly the second molars. In drinking water containing high fluoride concentrations, the posterior teeth are usually affected. In areas where there are moderate fluoride concentrations in the water supply, premolars are the most commonly affected teeth along with the incisors. The pattern of fluorosis risk distribution in the permanent dentition is as follows: premolars > second molars > upper incisors > canines > first molars > lower incisors.

Around 65% of global endemic fluorosis is caused due to fluoride contamination in drinking water. Fluorosis is endemic in at least 25 countries worldwide.

In India, about 50% of groundwater sources have been contaminated by fluoride. It has been recorded that about 62 million people including 6 million children are affected with dental, skeletal and non-skeletal fluorosis. The states of Andhra Pradesh, Bihar, Chhattisgarh, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal are affected by fluoride contamination in water.

Overexposure to Fluoride

Various sources have been found to be the possible causes of overexposure to fluoride and can be classified as Systemic fluorides & Topical fluorides. Systemic fluorides include fluoridated water, table salt, milk and fluoride tablets, while topical fluorides include toothpastes, mouth rinse and fluoride varnishes and gels.

Fluorosis associated with topical fluoride is present only when there is inadvertent swallowing of the topical agents. Fluoride supplements are not recommended for children living in areas where the water supply has been fluoridated. Studies have shown 68% of fluorosis cases in optimally fluoridated areas; this could be due to the ingestion of fluoride toothpaste by children during the first year of life. About 17% of cases were a result of ingestion of fluoridated mouth rinses and 15% due to fluoride supplements.

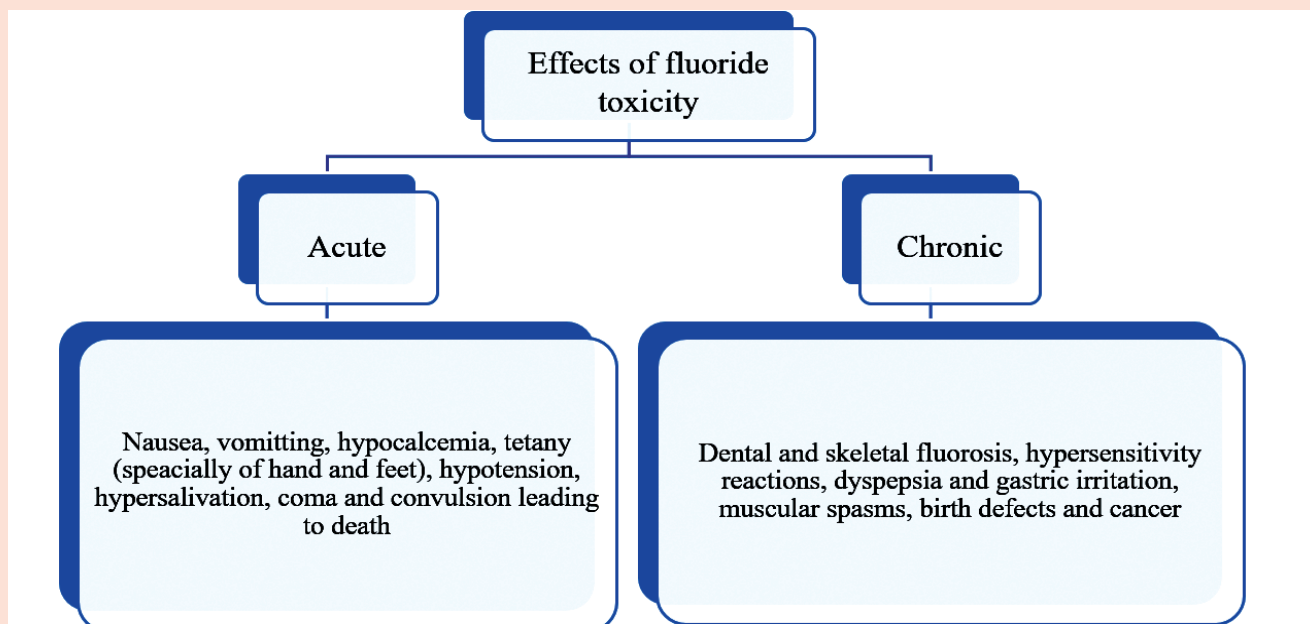
The fluoride toothpaste variables that have been associated with fluorosis are: beginning toothbrushing at a relatively early age, the amount of toothpaste used measured as either toothbrushing frequency, amount swallowed, or the amount of paste used at each brushing.

It has been found that powdered infant formula reconstituted with fluoridated drinking water may have a risk of developing mottled enamel. Children weaned before 9 months of age had a higher risk for fluorosis. It is possible that children who were weaned early were then fed infant formulas that were known to have higher fluoride content and so developed fluorosis.

The highest cases of fluoride toxicity were reported in children below 6 years of age (>80%). The toxicity of fluoride due to excessive ingestion can be classified into acute and chronic toxicity.

Fluoride in Enamel

Developing enamel: In the early developmental stages, minute levels of fluoride are detected and if relatively high concentrations of fluoride are consumed in the diet and drinking water, the enamel being porous, it readily absorbs the fluoride which creates a zone of relatively high fluoride enamel usually found before mineralisation of enamel begins.



Erupted enamel: Fluoride disrupts the maturation process, thus prolonging the time period during which the enamel is porous and therefore the period of rapid fluoride uptake will be extended. The fluoride content in the mineralised enamel is significantly increased when solutions, gels, or pastes containing 1000 to 10,000 ppm of fluoride are applied to the tooth surface at low pH. Changes in enamel such as open carious lesions, incipient caries, microcracks, and hypomineralised areas may be observed.

Defluoridation

There is a lack of sustainable treatment measures for any form of fluorosis. Hence, prevention and control interventions such as the provision of safe water and food have been found to be the best approach to mitigate fluorosis. There are various techniques which can be applied for water defluoridation such as:

Adsorption: This technique involves the adsorption of fluoride ions onto the surface of an active agent. The material retains fluoride either by physical, chemical or ion exchange mechanisms. Various agents used in this technique include Activated alumina, Bone char, Calcined clay, Mud pots, and Natural adsorbents.

Ion exchange: The different ion exchange materials include bone, bone char, anion and cation exchange resins such as carbon, defluoron-1, defluoron-2, etc.

Precipitation: Chemicals added to raw water cause precipitation of the fluoride salt as insoluble fluorapatite, which is separated from the water. Commonly used materials include aluminium salts, lime, Poly Aluminium Chloride, Poly Aluminium Hydroxy sulphate and Brushite. Following are precipitation techniques:

a. Nalgonda Technique: It involves the addition of Aluminium salts, lime and bleaching powder followed by

rapid mixing, flocculation, sedimentation, filtration and disinfection. Aluminium sulphate or aluminium chloride or a combination of these two are responsible for the removal of fluoride from the water.

b. Contact Precipitation: In this technique, the precipitation of fluoride is done by adding calcium and phosphate compounds.

c. IISc Method: This method uses magnesium oxide, calcium hydroxide and sodium bisulphate. Magnesium oxide removes dissolved fluoride ions by precipitating fluoride as insoluble magnesium fluoride.

Other techniques include reverse osmosis, electrolysis and electro dialysis and distillation. Nutritional interventions may also work. This involves the intake of foods rich in calcium, vitamins C and E and antioxidants, along with consuming safe drinking water.

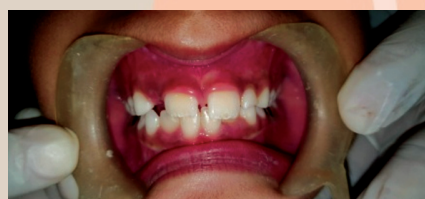
Treatment

The treatment options for fluorosis depend on the severity of the condition. These include non-invasive and minimally invasive techniques. Non-invasive methods include removing the surface stained areas through teeth bleaching, using microabrasion techniques, and resin infiltration; while invasive techniques include using composite resin restorations, veneers, laminates or crowns.

Bleaching: Different bleaching approaches for vital teeth include in-office or power bleaching, at-home or dentist-supervised night-guard bleaching, and bleaching with over-the-counter products. In partially erupted young permanent teeth having large pulp chambers, bleaching with 5% sodium hypochlorite is an excellent alternative for fluorosis stains. Various bleaching products such as acids, calcium sucrose phosphate, carbamide peroxide, hydrogen peroxide and sodium hypochlorite at different concentrations

Treatment for Fluoride Toxicity

Fluoride/kg body weight	Treatment
<5mg/kg	• Oral administration of milk to relieve GIT symptoms • Observe for a few hours • Induced vomiting is not required
>5mg/kg	• Hospital administration • Empty stomach using emetics; if patient has depressed gag reflex, perform gastric lavage • Oral administration of soluble calcium • Observe for a few hours
>15mg/kg	• Immediate hospital admission • Immediate gastric emptying • Begin cardiac monitoring • Intravenous administration of 10% calcium gluconate solution • Electrolyte should be monitored • Maintenance of adequate urine output • General supportive measures for shock



Mild fluorosis (left), Moderate fluorosis (centre) & Severe fluorosis (right)

can be used. Side effects such as tooth sensitivity, reduction in enamel microhardness and soft tissue irritation are commonly seen.

Micro abrasion: This technique involves the removal of a small amount of surface enamel and incorporates both abrasions with dental instruments and erosion with an acid mixture. It is mostly used to treat mild and superficial stains that do not extend into the deep enamel layers. Micro abrasion followed by the use of remineralising agents has been proven to give better results in the treatment of fluorosis stains. Recent studies show a combination of micro abrasion and vital bleaching results in recovery of the original colour with minimal complications, such as sensitivity in young patients. However, with this technique, substantial amounts of enamel have to be eroded to improve the appearance; there is increased enamel surface roughness, colour change due to the loss of enamel structure resulting in yellowish appearance.

Resin infiltration: It is a new material for caries infiltration, which can be used as an alternative approach to treat and prevent further progression of enamel lesions. This treatment focuses on sealing the microporosities within the lesion body by infiltration with low-viscosity light-curing resins that have

been optimised for rapid penetration into the porous enamel. After etching is done, resin infiltrant is applied to the lesion. The advantage of resin infiltration is that the enamel lesion loses whitish appearance.

Veneers: Ceramic veneers are the treatment of choice in cases of moderate to severe fluorosis to mask tooth discolouration. This can be achieved with minimal reduction of sound tooth structures as they require minimally invasive design preparation. They provide long-lasting aesthetic rehabilitation.

Crowns: Ceramic crowns are used in cases of severe dental fluorosis. However, this technique is more invasive and requires a more natural tooth structure to be removed.

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