Original Article

Dental Fluorosis in Children: Review

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Abstract

Fluoride is required for bone and tooth formation, and fluorosis occurs when fluoride intake exceeds the normal limit. Mottling and pitting of enamel caused by excessive fluoride consumption can lower one's self esteem due to an unattractive appearance. Preventive management of dental fluorosis includes de-fluoridating drinking water in endemic areas, using fluoride supplements with caution, and supervising the use of fluoride toothpaste by children under the age of five. Bleaching, micro-abrasion, veneering, and crowns can be used to treat aesthetically. The choice between these treatments is determined by the severity of the fluorosis.

Keywords: Dental fluorosis, Ameloblast, Nalgonda technique, Stains, Tooth mottling.

INTRODUCTION:

Fluoride is the name given to the negatively charged ion of the fluorine atom (F). Fluorine has the letter F as its symbol. Fluoride is often written as F^-, which stands for the -1 electrically charged fluorine anion. Fluoride is the name for any chemical or inorganic substance that contains the fluoride ion. Fluoride, which is necessary for the mineralization of bones and the development of tooth enamel, is present in bones and teeth in amounts of about 96 percent.[1] The most common sources of ingested fluoride are fluoridated drinking water, toothpaste, supplements, and formula for children.[2] The World Health Organisation and the Indian Council of Medical Research have advised that 1.5 ppm of fluoride be allowed in drinking water. [3] Dental fluorosis was primarily observed in endemic regions where increased fluoride intake was due to drinking water.[4] There are three basic forms of fluorosis: dental, skeletal, and non-skeletal. Due to the country's lack of good quality drinkable water and the consumption of fluoride-enriched water by both urban and rural residents, dental fluorosis is a multifactorial condition that affects individuals globally.[5]

Dental fluorosis, which is characterised by increased subsurface enamel porosity and a well-mineralized surface layer of enamel, can be brought on by excessive fluoride exposure. Ameloblast, the cell that forms enamel, will be impacted by high fluoride concentrations during tooth development, especially during enamel creation. Reduced free calcium ion concentration in the mineralizing matrix as a result of increased fluoride during enamel mineralization prevents enzyme proteinases from degrading the matrix proteins during the maturation phase.[6] Matrix protein degradation is therefore postponed. In order to benefit from fluoride's favourable effects on caries prevention while also preventing fluorosis, it is crucial to maintain fluoride exposure at recommended levels.

HISTORICAL PERSPECTIVE OF FLUOROSIS:

The journey of fluorosis started way back when for the first time abnormal stains were discovered distinctly on the tooth. These stains created deep sense of curiosity in people and led to embark the journey of dental fluorosis.
Frederick McKay, a fresh graduate from dental school, relocated to Colorado Springs in 1901 to establish a dental office. He was shocked to find that many of the locals had dark stains on their teeth, which the locals called it as "Colorado Stain". Sometimes these stains were so intense that they gave the impression that their teeth were coated in bitter chocolate. McKay noticed this and frantically began to research the illness that was producing the stains.

Dr. G.V. Black, a prominent dental researcher, was approached by McKay to assist him in identifying the source of the stain plaguing Colorado Springs residents. Black accepted the invitation and travelled to Colorado in 1909. The two collaborated for six years and discovered that about 90% of Colorado Springs-born children had the stain. They gave the brown stain a more scientific term (tooth mottling, later altered to fluorosis), and they were shocked to learn that teeth with mottling were remarkably resistant to dental decay. They recognised the stain's anti-cavity properties but were unable to determine the reason of tooth mottling, so they went on.
McKay was constantly on the lookout for a solution to the brown stain problem. So much so that he travelled from Colorado Springs to Oakley, Idaho in 1923 to investigate a recent increase in tooth mottling there. The parents claim

that soon after Oakley constructed a community water conduit to a warm spring five miles away, the stains began to appear. After testing the water and concluding that it was normal, McKay persuaded the town's officials to abandon the pipeline and switch to a local spring as their water source. The town complied, and the brown streaks vanished after a while.

Despite not having identified the exact cause, Mckay was able to identify the tooth mottling's source. Then, McKay travelled to Bauxite, Arkansas a community that is home to the Aluminum Company of America's aluminium facility (ALCOA). Bauxite people had discoloured teeth, but not the population of the adjacent towns. After asking the community to research the water, McKay left for Colorado.

A few days after the investigation was finished, Churchill discovered that the water at Bauxite contained significant amounts of fluoride.

In the letter, Churchill notified McKay of the fluoride findings and advised him to examine samples from Colorado Spring and Oakley for higher fluoride concentrations. In a few months, McKay discovered the solution to the brown stain issue: elevated fluoride levels were, in fact, staining teeth.

The National Institutes of Health (NIH) chose to research water-borne fluoride and its effects on teeth after learning about Mckay and Churchill's findings. A technique to gauge water's fluoride content was initially developed by Dr. T. Dean and Elias Elvove. The NIH concluded that fluoride levels up to 1.0 ppm could not produce enamel fluorosis by the late 1930s.

Indian Perspective:

Twenty four countries, including India, are affected by this condition.[7] There have been 85 million deposits of fluoride on the earth's crust, but only 12 million have been found in India .[8] A recent report showed that 66 million individuals from 275 districts are at risk of fluorosis in India.[9] Another report showed that 6 million children in India were estimated to have fluorosis.[10] The states of Haryana, Karnataka, Madhya Pradesh, Andhra Pradesh, Bihar, Chhattisgarh, Orissa, Punjab, Rajasthan, Tamil Nadu , Maharashtra ,Uttar Pradesh and West Bengal are affected by fluoride contamination in water. This involves about 9000 villages affecting 30 million people.[11]

Estimated Daily Intake of Fluoride:

The National Research Council has estimated “adequate and safe” daily fluoride intakes to be 0.1–0.5 mg for infants less than 6 months of age, 0.2–1.0 mg for infants between 6 and 12 months, 0.5–1.0 mg for children between the ages of 1 and 3 years, 1.0–2.5 mg for 4- to 6-year-old children, 1.5–2.5 mg for children from 7 years to adulthood and 1.5–4.0 mg for adults (National Research Council, 2001).

Fluoride Concentration in Drinking Water:

The maximum permitted level of fluoride in water has been set by the World Health Organization (WHO) at 1.5 mg/L. However, in 1984, WHO recommended that the ideal fluoride concentration in drinking water should remain below 1 mg/L while in cooler region, it could go up to 1.2 mg/L. As a result, the Bureau of Indian Standards has established Indian standards as 1.0 mg/L as the maximum permissible limit of water.[12]

Dental Fluorosis:

Dental fluorosis is a very prevalent condition that is defined by the hypomineralization of tooth enamel brought on by ingesting too much fluoride during the development of the enamel. Children who have moderate to severe dental fluorosis exhibit an increased incidence of dental caries. The enamel prisms of severely fluorosed enamel have huge, uneven holes between them, which allows bacteria and acid to readily diffuse in. It seems to be a variety of visual alterations in the enamel that result in varying degrees of intrinsic tooth discolouration and occasionally even actual harm to the teeth. The seriousness of the condition depends on the patient's age, dosage, duration and exposure.[13] It is well known that drinking water fluoride levels and dental fluorosis are related. The three main additional factors which can contribute to dental fluorosis are fluoride supplements, fluoridated toothpaste, and baby formula consumed before the age of seven [14]. Dental fluorosis is most concern for aesthetic in the permanent dentition. Dental fluorosis is more likely to occur in kids having too much fluoride exposure between 20 and 30 months of age. It is also crucial to remember that a child would not be at risk until they were between the ages of 1 and 4 when it comes to fluoride overexposure.[15] Clinically, The symptoms of dental fluorosis include mottled enamel, pitted enamel, brownish staining of the teeth, and bilateral diffuse, thin, horizontal white striations with stained plaque.[16]The spots and stains left by fluorosis are permanent and may darken over time. Additionally, the thickness of the enamel affects how severe the fluorosis is in the teeth. As a result, dental fluorosis, which is indicated by the appearance of snow-capped cusp tips and incisal edges, is more severe the thicker the enamel [17]. Although fluorosis is symmetrically distributed, the degree of severity varies depending on the type of tooth. [18,19] Premolars, which form and mineralize later in life, are particularly affected by fluorosis because it affects them more frequently and severely.[19,20] Dental fluorosis in the primary dentition can cause lesions with an asymmetrical pattern, but because the severity is lower than in the permanent dentition, there is less chance of structural loss.

Skeletal Fluorosis:

Skeletal fluorosis is a condition that develops after consuming excessive amounts of fluoride and is known to happen in regions where the majority of the drinking water is obtained from ground water. Compared to compact (cortical) bones,

cancellous (spongy) bones have a preference for accumulating fluoride because they have a superior blood supply. It happens when it affects the major joints and bones.[21,22]
Patients with skeletal fluorosis frequently report

- Diffuse discomfort and paraesthesia in the limbs and trunk, followed by back pain and stiffness particularly in the lumbar area, dorsal and cervical vertebrae.[23]
- Knock-knee syndrome is characterized by progressive outward bending of the leg and hands, during which these limbs lose their outlines.
- Children, pregnant women, and those who are nursing are the most vulnerable. If a pregnant woman takes too much fluoride, the foetus may also suffer harm.
- When fluorosis is severe, or "crippling fluorosis," the joints and spine become stiff and the patient is essentially immobile.

Skeletal fluorosis can occur if the fluoride concentration is in the range of 4 to 10 mg/L.

MANAGEMENT:

Fluorosis can be prevented by staying away from excessive consumption of fluoride by individuals and communities. The consumption of fluoride by humans comes primarily from drinking water. Fluoridation of groundwater has a variety of reasons due to India's huge geographic area and diverse geological structure. The natural discharge of fluoride into groundwater is beyond our control. However, it is avoidable for businesses like steel, aluminium, and brick kilns to contaminate groundwater. Groundwater contamination is a major issue, and quick action is required to address this situation. Finding and sealing off polluted tubewells is the first step. People must simultaneously be given access to clean drinking water from state-drilled tubewells.
Although prevention is the best course of action for dental fluorosis, restorative care may be required for severely fluorosed teeth.

Preventive Measures:

Dental fluorosis is best managed through prevention, however when teeth are severely fluorosed and are unsightly, restorative care may be necessary. In less severe cases of discolouration, procedures like tooth whitening or microabrasion may be beneficial. In severe cases where a significant portion of the enamel structure has been compromised and caries is present, these minimally invasive procedures are ineffective and necessitate a more extensive restorative procedure to restore ideal function and appearance. Parents must take the required steps to protect their children's teeth from dental fluorosis.

- Infant formula concentrates should be dissolved in fluoride-free or little fluoridated water before being combined.
- Unless directed to do so by a dentist, wait until the child is 2 years old before using fluoride toothpaste.
- Use only a pea-sized amount of fluoride toothpaste on the toothbrush when brushing a youngster who is two years old or older.
- Avoid toothpastes with aroma that can tempt to eat them. Children under the age of six should use fluoride-containing dental products under the supervision of an adult, who should also watch out for ingested fluoride.[24]

Electrolyte Defluoridation, Chemical Precipitation - Alum Coagulation (Nalgonda process):

The "Nalgonda Technique", developed by the National Environmental Engineering Research Institute (NEERI), Nagpur, is a cost-effective and straightforward method for removing fluoride. Alum salts, lime, and bleaching powder are added using the Nalgonda Technique, which is then quickly mixed, flocculated, sedimented, filtered, and disinfected. Aluminum sulphate (alum), aluminium chloride, or a combination of these two forms of the salt can be added. It is in charge of taking fluoride out of the water. Fluoride and alkalinity levels in raw water cause an increase in the amount of aluminium salt that must be used. To prevent them from exceeding their permitted limits, aluminium sulphate or aluminium chloride are chosen depending on the sulphate and chloride concentrations of the raw water. Lime makes it easier to build dense flocks so that insoluble fluoride salts can settle quickly. Empirically, the dose of lime is one-twentieth that of aluminium salt. In order to disinfect the raw water, bleaching powder is added at a rate of 3 mg/l. The method is suitable for both community and domestic settings. 20 litres water is combined with lime, alum, and bleaching at the household level (doses of alum and lime are established after analysing the fluoride levels and alkalinity of the water) and left to coagulate and settle. For at least one hour, the flocks should be kept at the bottom of the bucket. The treated water is withdrawn from the bucket by a tap 5 cm above the bottom, safely above the sludge level. Keep the water for drinking in a separate bucket and throw away the sludge.[25]

Electrolyte Defluoridation:

NEERI has created a solar energy-based electrolytic plants in some regions where fluorosis is endemic. In the presence of direct current, aluminium electrodes in excessively fluorinated water these produces active species of aluminium hydroxide, in which the fluoride ions in the water are absorbed, leading to sludge formation and treated water (used for drinking). In areas where a power exists installation of a solar-powered system is possible. Sludge that is dry can be discarded in a landfill or used to produce bricks.[25]

Therapeutic Measures:

Depending on how severe the illness is, dental fluorosis must be treated therapeutically.

Bleaching:

Teeth that are discoloured or mildly fluorosed have been treated using in-office, at-home, or a combination of both bleaching methods. The two most used bleaching chemicals are hydrogen peroxide (35%) and carbamide peroxide (10%). For in-office bleaching, bleaching gels with high hydrogen peroxide concentrations (like 35% hydrogen peroxide) are utilised. Until the ideal shade is achieved, the in-office bleaching may be followed by at-home bleaching.[26]

Microabrasion:

The controlled removal of surface stains from enamel is known as microabrasion. The method is utilised to get rid of mild-to-moderate fluorosis-related stains. To efficiently remove fluorosis stains, bleaching is frequently combined with microabrasion. Typically, when the enamel discoloration is no deeper than 0.2-0.3 mm, microabrasion is advised.[27] After microabrasion, amorphous calcium phosphate (ACP) was used to lessen tooth hypersensitivity.[28] ACP and casein phosphopeptide (CPP) have the ability to form a combination that, by promoting remineralization, can lessen the opaque white discolouration of enamel fluorosis.

Laminate Veneers:

When there has been surface enamel loss, laminate veneers are utilised to treat severe dental fluorosis. The veneer could be constructed of composite resin or porcelain. When more over 30% of the labial enamel has been destroyed, laminate veneer is not advised because adhesive bonding to enamel generates more predictable results than bonding to dentin.[26] The track record of porcelain laminate veneers is excellent. They are biocompatible in addition to having great look and predictability.[29]

CONCLUSION:

An important risk factor for paediatric dental, skeletal, and non-skeletal fluorosis is rising water fluoride levels. Clinicians should be aware of the proper fluoride supplement dosage and take into account the child's risk of developing caries before prescribing fluoride supplements.

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