PERSPECTIVE

Is There a Need of Extra Fluoride in Children?

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The issues related to fluoridation of water or fortification of tooth paste with compounds of fluorides are controversial. Fluoride is stored mainly in the bones, where it increases the density and changes the internal architecture, makes it osteoporotic and more prone to fractures. Fluoride consumption by human beings increases the general cancer death rate, disrupts the synthesis of collagen and leads to the breakdown of collagen in bone, tendon, muscle, skin, cartilage, lungs, kidney and trachea, causing disruptive effect on various tissues in the body. It inhibits antibody formation, disturbs immune system and makes the child prone to malignancy. Fluoride has been categorized as a protoplasmic poison and any additional ingestion of fluoride by children is undesirable.

Keywords: *Child, Fluoride, Fluorosis, Fortification, Toxicity.*

Fluoride, a trace element, has been a matter of controversy for human consumption since long. Initially it was proposed that a minimum concentration of fluoride is needed for good strength of bone and teeth, but subsequent evidence stated that there is no need of extra fluoride for human consumption. The minimum recommended fluoride levels in drinking water are 0.6 mg/L and 0.2 mg/L, respectively by World Health Organization (WHO) and 'Indian Standard Code for Drinking Water [IS 10500 (1991)]', whereas the upper limits are 1.5 mg/L and 1.0 mg/L, respectively(1,2). At the same time, IS 10500 (1991) recommendations also state that fluoride in drinking water should be kept as low as possible. Fluoride when consumed beyond permissible limits is highly toxic and leads to fluorosis. Although there are several sources of fluoride intake, it is roughly estimated that 60% of the total intake is through drinking water. This is also the most assimilable form of fluoride and hence the most toxic.

Systemic fluorosis has been reported to be endemic in several developing countries, including India, due to limited availability of good quality drinking water. In India, seventeen states are endemic for fluorosis, of which five are hyperendemic. People in several districts of India are consuming water with fluoride concentrations up to 44 mg/L. Other common sources of fluoride for humans include food, air, medicament and dental products such as toothpastes and mouth rinses. In view of widespread prevalence of fluorosis in India, the need to fortify dental products with high concentrations of fluoride has been challenged repeatedly.

PRESENT FLUORIDE INTAKES

Considering the permissible limit of fluoride i.e.1.5 mg/L in drinking water, and daily permissible intake recommended as per ***Table* I**(3), it is evident that fluoride ingestion is already beyond safe limit through drinking water only. Any further ingestion of fluoride as a medication or cosmetic is therefore unacceptable. The fluoridated tooth pastes have been reported to contain fluoride in concentrations up to 1100-1800 mg/L of paste(4). Thus, a 200 g pack of such toothpaste will contain 220-360 mg of fluoride and one brushful of such paste provides approximately 1.0 to 2.0 mg of fluoride, which is

TABLE I AVERAGE DAILY PERMISSIBLE FLUORIDE INTAKE

Age	Weight	Daily permissible intake
0-6 months	16 pounds (7 kg)	0.01 mg
6-12 months	20 pounds (9 kg)	0.5 mg
1-3 years	29 pounds (13 kg)	0.7 mg
4-8 years	48 pounds (22 kg)	1.1 mg

Adapted from reference 3.

well above the daily recommended intake. The acute lethal dose of fluoride is about 22 mg per kg(5). With no margin of safety, accidental ingestion of fluoridated tooth paste may even cause death in children. Many studies have indicated that the use of fluoridated toothpaste is a cause of fluorosis(5).

TOXIC EFFECTS

The Food and Drug Administration (FDA) of United States considers fluoride an unapproved new drug for which there is no proof of safety or effectiveness. The FDA does not consider fluoride an essential nutrient. It has been estimated that fluoride causes more human cancer death, and causes it faster, than any other chemical(6). Many countries *e.g*. China, Austria, Belgium, Germany, Japan, Denmark, Switzerland etc. have rejected addition of fluoride for legal reasons and because the so-called optimal fluoride concentration of 1.5 mg/L is close to the dose at which long-term damage to the human body (more in children then adults) have been reported(7). The fluoride induced effects include damage to the teeth, skeletal fluorosis, adverse neurological effects like Attention Deficit Disorder, reduced intelligence quotient (IQ) in children, oxidative stress and premature ageing. Fluoride containing dental products are usually prescribed by doctors to reduce the tooth decay despite its questionable efficacy(6).

Dental fluorosis has been reported in 30% of children drinking water with only 0.7 mg/L of fluoride(6). 8% to 51% of the children growing up in areas where drinking water contains more than one part per million (1 mg/L) of fluoride have dental fluorosis(6). In extreme stages, fluoride damages the enamel permanently causing enamel hypoplasia.

Excessive fluoride ingestion also causes damage to bones causing *skeletal fluorosis*. It is a crippling bone disease and have been reported at drinking water fluoride levels as low as 2.3 mg/L. Skeletal fluorosis is characterized by hyperostosis, osteopetrosis and osteoporosis(8), causing joint pain, numbness and tingling of the extremities, back pains, knock-knees and other joint deformities.

Fluoride ingestion may also cause hypocalcemia with resultant secondary hyperparathyroidism(3,8). Reports indicate that lowering of blood ionized calcium by an amount as low as 0.02 mmol/L within 30 minutes elicit an immediate large, transient peak release of parathyroid hormone (PTH) amounting to 6-16 times the baseline concentration(8). This secondary hyperparathyroidism results in maintenance of serum calcium by increase in tubular reabsorption of the filtered calcium and also by increased bone resorption. This leads to defective bone formation, osteopenia and defective collagen (ground substance) formation(3,8). In skeletal fluorosis, osteopenia is more evident in children whereas in adults it gives a picture of osteoporosis. The amount of fluoride detected in ash of the normal adult bone is 0.5-1 gm/kg whereas it ranges from 3.5 gm/kg to 8.4 gm/kg of bone ash in skeletal fluorosis(9).

Fluoride crosses the blood-brain barrier and accumulates in cerebral tissue even before birth and has been reported to affect the intelligence(10). High fluoride ingestion in children has been reported to cause poor school performance, low IQ, an increase in reaction time affecting the attention process and hence low scores in visuospatial organization affecting the reading and writing abilities, reduced mental work capacity and reduced hair zinc in comparison to children consuming normal fluoride(11). The suggested mechanism for these manifestations is that the fluoride influences calcium currents, altering enzyme configuration by forming strong hydrogen bonds with amide groups, inhibiting cortical adenylyl cyclase activity and increasing phosphoinositide hydrolysis affecting the brain functions(11).

A close association between chronic fluoride toxicity and increased oxidative stress has been reported in humans(12,13). Fluoride reduces ascorbic acid, an important antioxidant, in serum and

in leucocytes(14,15). Fluoride has been demonstrated *in vivo* and *in vitro* to cause increased lipid peroxidation in erythrocytes. Decreased level of glutathione and uric acid, and an increase in activity of Glutathione peroxidase have been reported in children with endemic skeletal fluorosis(16,17). These observations indicate that chronic fluoride ingestion causes enhanced oxidative stress and has a propensity to make a person prone to many chronic disorders such as cancer and diabetes.

One of the severe manifestations of fluoride toxicity is premature ageing. The proposed mechanism is the effect of secondary hyperparathyroidism causing breakdown of collagen, the most abundant of the body's protein. It also leads to irregular formation of premature collagen which serves as a major structural component of skin, ligaments, tendons, muscles, cartilage, bones and teeth(18). Other factors adding to acceleration of the aging process by fluoride at the biochemical level are: enzyme inhibition(19); genetic damage(19); disruption of the immune system by inhibiting the migration rate of white blood cells to infected areas(20); interference with phagocytosis(18); and, the release of superoxide free radicals in resting white blood cells(18,19).

OTHER POSSIBLE EFFECTS OF INGESTION

Fluoride is reported to be an equivocal carcinogen by the National Cancer Institute Toxicological Program(21). Since fluoride mainly accumulates in bone, a 6.9 fold increase in bone cancer has been reported, mainly osteosarcoma in young males(22). Fluoride is a known goitrogen and has inhibitory effect on iodine uptake. In high fluoride areas, the thyroid enlargement prevalence rate in children is reported to be as high as 30%(23). Fluoride affects the cell mediated immunity by modifying T-cell functions(3). This is an important aspect in immunization since it can modify the immune response to vaccination. Relationship of fluoride and immunity needs more investigation.

Repetitive strain injury (RSI), a new clinical syndrome, is characterized mainly by severe pain in wrists, forearms, hands and fingers(24). RSI subjects have magnesium deficit and an excessive fluoride intake. Fluorotic bones have an increased magnesium content possibly due to some deposition of magnesium fluoride. A locally raised fluoride concentration in an osteocyte lacunae interferes with normal functioning of the cell, triggers the precipitation of crystalline apatite and lead to formation of magnesium fluoride. This reaction causes a localized magnesium deficiency which disturbs pyrophosphate metabolism and lead to deposition of calcium salts in sensitive areas.

Significant association has been observed between low birthweight and high fluoride intake during antenatal period(25). High fluoride intake during pregnancy interferes with fetal development, possibly due to transplacental passage of fluoride, which causes chronic suppression of calcium levels in mother and fetus. This leads to decreased total body bone mineral and poor bone growth, and secondary hyperparathyroidism in fetus, causing interference with soft tissue development by producing defective ground substance.

Some studies indicated a link between fluoride in drinking water and Down syndrome but later no such association was confirmed. However, 30% higher incidence of Down syndrome has been reported from high fluoridation areas(26).

FLUORIDE ALUMINIUM SYNERGISM

It is important to note that all currently available defluoridation processes use aluminum compounds which always leave residual aluminum in treated water(27). The toxicity of fluoride increases manifold in presence of aluminum, which is neurotoxin as well as bone toxin. Even in very low doses, the presence of aluminum with fluoride causes formation of alumino-fluoro complexes, which adversely affect the G proteins (guanine nucleotide binding proteins) of cells(28). The presence of residual aluminum in drinking water has become a major concern for public health and has been reported as a possible cause of Alzheimer disease(29). Presently, as per WHO, the maximum permissible limit for aluminum in drinking water is 0.2 mg/L, which may undergo further revision due to its neurotoxicity(2). As per IS 10500 (1991), the desirable limit of aluminum in drinking water is 0.03 mg/L and maximum permissible limit is 0.2 mg/L(1).

ECONOMIC MOTIVES BEHIND FLUORIDATION

Even though it has been proved that fluoride is dangerous for human health, especially in countries endemic to fluorosis, no action has been taken to withdraw its addition in tooth paste or mouth rinses. If economic motives are evaluated, the tooth paste manufacturing companies are charging extra money for adding this toxic ingredient! Even some companies are advertising fluoride as vitaminated fluoride in tooth paste.

CONCLUSIONS

The review of literature clearly illustrates that fluoride need not to be added through the process of fluoridation, as it does not serve any useful purpose. On the other hand, it acts as toxic agent even at fairly low concentrations. A downward revision of the safety standard of drinking water is required in terms of its fluoride content. There is a need to carry out more extensive studies in this direction to bring out a new standard, especially under Indian conditions. Further, defluoridation technologies should be re-evaluated based on efficacy for fluoride removal and residual aluminum in the treated water. The production of fluoride enriched toothpastes and mouth rinses should be stopped.

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