Fluoride's toxicity and its effects on the Central Nervous System

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ABSTRACT

Fluoride (F) is an element that occurs naturally on earth. Exposure to fluoride has negative effects on the human body and the intake mainly depends on what the person is consuming i.e. food, water, and air. Accumulation of fluoride occurs after continuous exposure to it as it can take 20 years or more to become evident and studies have shown that it affects various body parts including the renal, liver, and central nervous system.

Keywords: fluoride, toxic, factor, water, exposure, central nervous system

Introduction

Fluoride is a toxic nonmetal that occurs naturally in the environment. It is used in many industries so exposure to it goes unnoticed. Factors that are responsible for fluoride intake are toothpaste additives, tea, coffee, water, meat, shellfish, food supplements etc. It is widely used for the prevention of dental caries.

There are a few fluoride-containing medications too. For example, voriconazole (oral antifungal medication). A typical dose of voriconazole provides 65 mg/day of fluoride. Long-term usage can lead to high fluoride concentrations in serum.

World Health Organization (WHO) recommends fluoride concentration to be below 1.5 mg/l. But one of the most responsible factor for fluoride toxicity in the human body is water as there are many geographical places where the concentration of fluoride in water is very high and dangerous for long-term usage. Such places include Eastern parts of Africa like Kenya and Ethiopia and Southeast Asia. In India, 70 million people are exposed to elevated levels of fluoride. People in these areas suffer various health issues like fluorosis.

The aim of this paper is to shed some light on fluoride's toxic nature and its effects on the central nervous system, which helps in warning people about the harmful effects of fluoride-containing 'daily intake products' including food and water.

Advancement

As stated, the daily exposure of the human body to fluoride mainly depends on the intake of this element. Appropriate intake of fluoride is beneficial for bone and tooth integrity. The incorporation of Fluoride in the human body is the digestive tract; 75% - 90% of the received fluorine is absorbed in the stomach and intestines, and 99% of the fluorine is transported to calcium-enriched tissues. Around 60% of F is stored in adults. In Children, 80% - 90% of absorbed fluorine gets accumulated. It is worth mentioning that this affinity decreases with the age.

Several clinical and experimental studies have reported that F induces changes in cerebral

morphology and biochemistry that affect the neurological development of individuals as well as cognitive processes, such as learning and memory. Retrospective studies have shown that the symptoms of fluorosis (the disorder of physiology of bones and teeth and the damage to soft tissue) appeared when the supply of fluorine was over 0.12 mg/kg/day.

Prolonged exposure to Fluorine in the prenatal and postnatal stages of development has a toxic influence on the metabolism and physiology of neurons and glia. This can also cause biochemical and functional changes in the nervous system. The exposure of children to fluorine is possible due to the fact that fluorine has the ability to penetrate the placenta and is able to cross the blood-brain barrier. This can result in disorders in the processes connected with memory and learning. Studies have shown that children who live in areas where the fluoride content in drinking water is high, have significantly decreased levels of intelligence in comparison to children from regions not contaminated with fluorine. Juveniles are less resistant to the toxic influence of fluorine due to the fact that their defense mechanisms are not fully developed and the permeability of their blood-brain barrier is higher than among adults. However, the exact mechanisms by which fluorine decreases cognitive and learning abilities and causes memory loss were not clearly defined. But it was observed that the levels of neurotransmitters and their receptors and Purkinje cells were decreased in the brain of aborted fetuses in the areas with cases of endemic fluorosis. Other symptoms include deterioration of dendrites and degeneration of axons. It can also cause swelling of the mitochondria, damage to the synaptic membrane, and disorders in the synthesis of tubulins which might lead to the formation of malfunctioning neurons (neurons without the ability of signal transmission). These types of effects prove that F can impact the cell growth and transmission of neuro-signals which has a direct impact on the central nervous system.

Fluoride also has an inhibitory effect which can lead to significant changes in the morphology of the hippocampus, amygdala, cortex, and cerebellum.

Experimental studies on rats have been done in regard to the effect of fluorine on the central nervous system. These studies have shown that the accumulation of fluorine also influences the content of Nissl Bodies, which are concentrations of ribosomes and RNA in neurons. These concentrations are responsible for the characteristic colour of grey matter. Another research showed a negative influence of fluorine on the volume of neurons. The Homeostatic process of the body is directly related to the volume of cells and concentration of ions.

In another study, the offspring of rats were given doses of 5, 15, and 50 ppm of F in their drinking water (during lactation and gestation), and a significant increase of acetylcholinesterase enzyme was seen, 80 days after the birth. They said that the enzyme degrades the neurotransmitter ACh. Ach plays an important role in regulating functions like a transition from sleep to wakefulness and processes that have to do with learning and memory. It was seen that both learning and memory cognition were low in the rats who drank water with high fluorine concentration as compared to those who drank water with low F concentration.

There were some studies performed on humans too which showed that people who were exposed to fluoride due to industrial contamination have faced concentration issues, memory issues and general fatigue. Another study on humans in China showed that a concentration of 3-11 ppm of fluoride in drinking water affects the functioning of nervous system without causing any physical effects. The IQ (intelligence quotient) of children who were exposed to high concentrations of F was found to be significantly lower than that of children living in lower exposure to F.

Conclusion

Exposure to fluorine for a long time can have many negative effects. It can be on reading and writing abilities, learning and memory capabilities, visual-spatial organization, homeostatic capabilities, and many more. The Central Nervous System during the early

childhood or juvenile stage is highly sensitive to the influence of F and exposure to this can cause permanent damage to the body and brain capabilities. In both young ones and adults, we can see the toxic influence of this element; and because the abundance of F is very high on the planet earth, exposure to it is quite easy depending upon the geographical location, which is why the intake of F should not cross the accepted limit by WHO (World Health Organization) i.e. 1.5 mg/L.

Acknowledgments

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