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Fluoride Status and Toxicity: A Review

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Abstract :
Fluoride if often called a two-edged sword, inadequate intake of fluoride causes dental caries whereas excess intake causes dental and skeletal fluorosis and other ill effects on human health. Its excess ingestion into human body slowly converts the working productive and healthy population into non functional, unproductive and burden on society. The seriously affected people became a live dead body which does not able to perform their daily life function. It become on evil for socioeconomic, mental, physical and healthy development of affected population in world wide. This paper presents a review, which focuses on the sources of fluoride in drinking water, status and fluoride toxicity.

Key Words – Fluoride, Dental Fluorosis, Skeletal Fluorosis and Toxicity

INTRODUCTION:

Fluorine is the 13th most abundant element on earth. It cannot exists outside a controlled environment without combining with other substances to become fluorides. Three main anthropogenic sources were identified as fertilizers, combusted coal and industrial waste with phosphate fertilizer being the most significance source of fluoride[1]. There are ionisable and non-ionisable, organic and inorganic fluorides. Fluorine is probably an essential element for animals and humans. Low concentrations provide protection against dental caries, especially in children. Minimum concentration of fluoride in drinking water required to produce protective effects is approximately 0.5mg/L.Soluble inorganic fluorides ingested through water and foods are almost completely adsorbed from the gastrointestinal (GI) tract by a process of simple diffusion. When ionic fluoride enters the acidic environment of stomach lumen, it is largely converted into hydrogen fluoride[2]. It is rapidly distributed by the systemic circulation to the intracellular and extracellular sites of tissues. However, ion normally accumulates only in calcified tissues such as bone and teeth. In blood ion is asymmetrically distributed between plasma and blood cells, so that the plasma concentration is approximately twice as high as that associated with the cells[3]. Fluoride is distributed from plasma to all tissues and organs. In humans and laboratory animals, approximately 99% of the total body burden of fluoride is retained in bones and teeth, with remaining distributed in highly vascularised soft tissues and the blood. Fluoride is concentrated to high levels within the kidney tubules, so this organ has a higher concentration than plasma. Ingested fluoride that is not adsorbed into the GI is excreted in the faces. Some fluoride is also lost from the body through sweat.The problem of Fluorosis is worldwide affecting many countries, Sporadic incidence of high fluoride content in groundwater has been reported from India, China, Sri Lanka, West Indies, Spain, Holland, Italy, Mexico, North and South American countries. India and China, the two most populous countries of the world, are the worst affected and in India especially Rajasthan which is the largest state of India.

Status of Fluoride in India :

In 21th century, India more than 35 million populations of 19 states is consuming fluoride above permissible limit through drinking water. In 1991, 13 of India's 32 states and territories were reported to have naturally high concentrations of fluoride in water, but this had risen to 17 by 1999[4]. At present 62 million people, including 6 million children suffer from fluorosis because of consuming fluoride contaminated water[5]. This is indicating that endemic fluorosis is the most alarming public health problem of the country. The most seriously affected areas are Andhra Pradesh, Punjab,

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Bihar, MadyaPardesh, Haryana, Rajasthan, Gujarat, Tamil Nadu and Utter Pradesh.Endemic skeletal fluorosis was reported from India in the 1930. It was observed first in Andhra Pradesh bullocks used for ploughing, when farmers noticed the bullock's inability to walk, apparently due to painful and stiff joints. Several years later the same disease was observed in humans[6]. The prevalence of dental fluorosis has been investigated in Rajasthan. Examined the prevalence of dental fluorosis at lower drinking water fluoride concentrations in the Jhajjar district, Haryana. Concentration of fluoride in ground water varies state to state in India, fluoride concentrations recorded indifferent state by different are Angul-Talcher, Orissa 0.2-2.4mg/L, Guwahati, Assam 0.18-6.88mg/L, Balasore, Odissa 0.6-5.83mg/L, Rohtas, Bihar 0.1-2.5mg/L, Delhi 0.11-32.5mg/L, Dindigul (TN) 2.47-5.26 mg/L, Erode, (TN) 0.5-8.2mg/L[7].

Status of Fluoride in Rajasthan : In Rajasthan the first case of skeletal fluorosis was reported from Jobner near Jaipur city by Kalsiwal and Soloman in 1959. Later during 1964 in the villages of Nagaur and Bhilwara district high fluoride contents in drinking water were observed. All the 33 districts are endemic to fluoride problem but the district of Barmer, Nagaur, Rajsamand, Jalore, Tonk, Churu, Pali and Ajmer are worst affected[8]. On the other hand, the eastern part of the state is bordered by Haryana state where fluoride content is relatively higher, which to some extents influences the groundwater quality of northen Rajasthan due to its physiographical structure[9-12]. In Rajasthan, fluoride concentrations have been found between 0.6mg/L to 69.7mg/L.In state many fluoride affected pockets were identified different researcher such as Jahazpur, Bhilwara, Nagaur, Newai (Tonk), Sanganer (Jaipur), Bassi (Jaipur), Ladnu (Nagaur), Dungarpur, Dausa, Dholpur, Nagaur, Uniara (Tonk), Deoli (Tonk), Nawa (Nagaur), Malpura (Tonk), Sikar, Jodhpur, Barmer, Alwar, Ajmer, Bhilwara, Banera(Bhilwara), Hurda (Bhilwara), Raipur (Bhilwara), Dungarpur, Sirohi[13-14].

Toxicity of Fluoride:

Fluoride predominantly effects the skeletal systems, teeth and also the structure and function of skeletal muscle, brain and spinal cord[15]. General symptoms of acute fluoride poisoning includes nausea, salivation, vomiting, diarrhoea and abdominal pain. Fluoride is also found to be involved in the alteration of metabolism of some essential nutrients which leads to hyperkalemia, hypocalcemia, hypomagnesemia, hypophosphatemia. Persistent fluoride serum level leads to mineral homeostasis which ultimately causes cellular damage. Symptoms of acute fluoride toxicity have been summarized in Table.

Chronic fluoride toxicity occurs after the long-term ingestion of small amount of fluoride. It inhibits the synthesis of DNA, protein and inhibits cell proliferation and cytotoxic at high doses[16]. Symptoms of long term fluoride toxicity include emaciation, stiffness of joints and abnormal teeth and bones. Other effects include lowered milk production and detrimental effects on reproduction. Fluoride is known to cross the blood brain barrier and accumulate in the brain of animals exposed to high fluoride levels. Recent studies have shown accumulation of fluoride in the hippocampus of the brain causing degeneration of neurons, decreased aerobic metabolism and altered free-radial metabolism in liver, kidney and heart. Long term exposure to fluoride through various fluoride containing water and other products leads to development of fluorosis. Fluorosis is also known as a crippling and painful disease. Fluorosis includes skeletal, dental and non-skeletal fluorosis. Dental fluorosis occurs during the period of enamel formation. It is linked to excessive incorporation of fluoride into dental enamel and dentine, which prevents normal maturation of enamel. Skeletal fluorosis is a pathological condition which includes inhibition of bone hardening (mineralization), causing the bones to become brittle and their tensile strength may

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be reduced. Symptoms include limited strength of joints, skeletal deformities and intense calcification of ligaments, muscle wasting and neurological deficits.

CONCLUSION:

In a ground water of Rajasthan in many blocks fluoride concentrations is exceeding the prescribed limits of WHO and BIS. Excess intake of fluoride through drinking water is causing ill effects of human health as well as other habitants. The seriously affected people become a live dead body which does not able to perform their daily life function. It becomes an evil for socioeconomic, mental, physical and healthy development of affected population in world wide. The major sources of fluoride in ground water of Rajasthan isgeogenic. The health problems linked to fluoride are depend on socioeconomic status, literacy level, nutrition level, geography of habitation and availability of facilities to population. The excess concentration of fluoride becomes a big challenging toxicological and geo-environmental issue in Rajasthan.

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Table: Symptoms of acute fluoride poisoning

Gastric Symptoms	Electrolyte Aabnormalities	Neurological Effects	Cardiovascular Effects
Hypersalivation, Nausea Vomiting Diarrhoea Abdominal Pain Dysphagia Mucosal Injury	Hypocalcemia Hypomagnesemia Hyperkalemia Hypoglycemia	Headache Tremors Tetanic contractions Hyperactive reflexes Seizures Muscle weakness Muscular spasm	Widening of QRS Various arrhythmias Shock Cardiac arrest