PREVENTIVE DENTISTRY

Prevention and controlling of Dental caries

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Fluorides in Dentistry

Fluoride is the ionic form of fluorine, a halogen and the most electronegative of the elements of the periodic table .The caries-preventive effect of fluoride has been known since the 1930s .It is well documented that fluoride can have both beneficial and detrimental effects on the dentition. As a basic principle, the beneficial effects on dental caries are due primarily to the topical effect of fluoride after the teeth have erupted into the oral cavity. In contrast, the detrimental effects of fluoride are due to its systemic absorption during tooth development, resulting in dental fluorosis. By maximizing topical exposure throughout life and minimizing systemic absorption during the period when the dentition is developing, fluoride can be used to maximize the anticaries benefits while minimizing the risk of fluorosis .Evidences had proved the differences in caries prevalence between communities were attributed to naturally occurring fluoride levels in the drinking water.

Due to its safety, efficacy and cost-effectiveness in preventing caries the fluorides are widely used in different forms thus remains cornerstone of most caries prevention programs.

Fluoride in Environment

- *Fluorine* belongs to the group of chemical elements called halogens, which refers to their ability to form salts in union with a metal. Halogens, and in particular fluorine, are highly reactive being one electron short of a full outer shell.
- This electron can be gained by reacting with, for example, calcium, forming calcium fluoride (CaF2). Thus, fluoride is the term used when fluorine is combined with a positively charged counterpart. The complexes often consist of crystalline ionic salts such as fluorapatite (Ca10[PO4]6F2).
- Fluoride content is commonly expressed in parts per million,(ppm) which is equivalent to 1mg fluoride per kilogram or liter of water. Thus,1ppm fluoride equal to 1mg fluoride per liter of water

Fluoride in Our Surroundings

Fluoride occurs in nature as a constituent of natural minerals in the soil and more than 150 fluoride-containing minerals have been described. For example : cryolite contains aluminum fluoride , fluorspar contains calcium fluoride. As many of the minerals in the soil are soluble in water, fluoride is found in varying concentrations in the groundwater.

Fluoride in water and atmosphere

All water contains fluorides in varying concentrations. Sea water contains significant quantities of fluoride at levels 0.8–1.4 mg/lt.

In water from lakes, rivers, and artesian wells the fluoride content is usually below 0.5 mg /L although concentrations as high as 95 mg /L have been recorded in Tanzania. The highest natural fluoride concentration ever found in water was 2800 mg/L, recorded in Lake in Kenya.

Additional fluoride is widely distributed in the atmosphere, originating from dust of fluoride-containing soils from gaseous industrial waste, the burning of coal fires in populated areas and from gases emitted in areas of volcanic activity in nature.

The principal source of pollution are industries and mining of phosphate and fluorspar, where fluoride rich dust travel long distances by wind and enter food chain by depositing on plants. Pesticides containing fluoride can have a similar effect.

Fluoride in food

In food the uptake of fluoride varies among plant species, being influenced by soil, use of fertilizer, age of the leaf, irrigation and other factors. Tea plant has a fluoride concentration ranging from 3.2 to 400g/kg. Because of the ability of tea leaves to accumulate fluoride to concentrations exceeding 10 mg/100 g dry weight, brewed tea contains fluoride at concentrations ranging from 1 to 6 mg/liter depending on the amount of dry tea used, the water fluoride concentration, and brewing time . The concentrations in decaffeinated teas are approximately twice those of caffeinated teas. Vegetation grown in near of industrial facilities may show elevated fluoride concentrations because of the absorption of particulate and gaseous fluoride impinging on leafy surfaces. Also fluoride can be found in fishes and shell fishes.

In countries with water fluoridation programs, fluoridated water may raise the fluoride content of the processed food, juices, if fluoridated water is used for food processing more than that of the products for which non-fluoridated water has been used.

Other sources of fluoride are drugs like diuretics and anesthetics drugs, and in dental products e.g. dentifrices, mouth rinses and some restorative materials.

Fluoride Metabolism

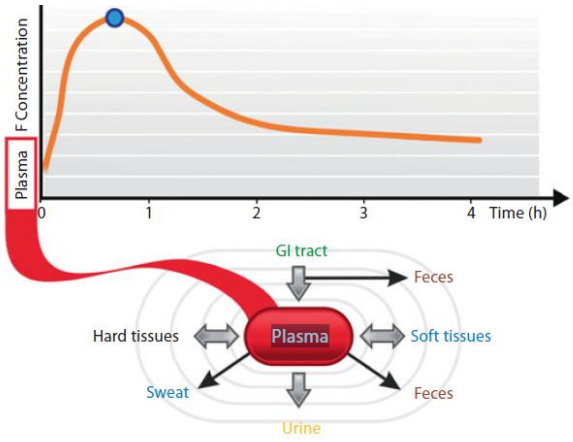
1-Fluoride Absorption

Fluoride combines reversibly with hydrogen to form the acid, hydrogen fluoride (HF). Much of the physiological behavior of fluoride (for example, its absorption from the stomach, distribution between extra- and intracellular fluid compartments and renal clearance) is due to the diffusion of HF. Approximately 75 to 90 percent of the fluoride ingested each day is absorbed from the gastrointestinal tract after approximately 30 minutes. In the absence of high dietary concentrations of calcium and certain other cations with which fluoride may form insoluble and poorly absorbed compounds. Body fluid and tissue fluoride concentrations are proportional to the long-term level of intake; they are not homeostatically regulated. Fluoride may also be inhaled from air borne fluoride. Readily soluble fluoride compounds such as NaF tablets or aqueous solution of NaF are completely absorbed where as compound with solubility such as CaF_2, MgF and $A1F_3$, are less completely absorbed. So the presence of Ca may lead to formation of insoluble salts with fluoride and absorption reduced to 60%- 70% . The ingestion of fluoride with food retards its absorption . Absorption from stomach occurs readily and is inversely related to the pH of the gastric content. The absorption process occurs by passive diffusion. The absorption of fluoride is unusual in that it can occur from the stomach to a considerable extent.The rate of gastric absorption is directly related to the acidity of the contents so that, for any given dose, the peak plasma level is higher and occurs sooner when the contents are more acidic . Most of the fluoride that escapes absorption from the stomach will be absorbed from the proximal small intestine.

2-Distribution of Fluoride in the Body

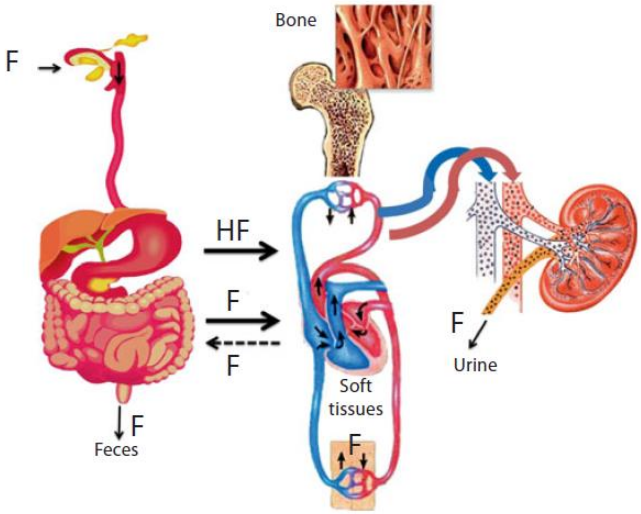
About 90% of fluoride intake is absorbed in blood from stomach and to lesser extent from small intestine and 10% excreted by feces.

A-Fluoride in Plasma



Plasma is the biological fluid into which and from which fluoride must pass for its distribution elsewhere in the body and for its elimination from the body.

Ionic fluoride is not bound to proteins, to other components of plasma or to soft tissue. The concentration of ionic fluoride in soft and hard tissue is directly related to the amount of ionic fluoride intake. The peak plasma concentration usually occurs within 30-60 minutes, then decreased within a few minutes after its distribution into body tissues through extracellular fluid , Baseline plasma fluoride levels are usually reached within 3–11 h after ingestion, depending on the amount ingested .in pregnant women fluoride passes placenta and found in fetal blood in about 70% of mother blood.



B-Soft Tissues

It depends on the extra cellular pH of cell, increase acidity increase the fluoride exchange through the tissue plasma. The fluoride distributed rapidly to heart, kidney, liver and slowly distributed to skeletal muscles and adipose tissues. So it is suggested that alkalization of the body fluid is a useful adjunct in the treatment of fluoride toxicity.

C- Calcified Tissues

Owing to its high affinity for calcium, fluoride is mainly associated with calcified tissues. Its ability to inhibit, and even reverse, the initiation and progression of dental caries is well known. Approximately 99 % of the body burden of fluoride is associated with calcified tissues. The fluoride concentration in bone is not uniform. In long bones, for example, the concentrations are highest in the periosteal region. They decline sharply within a few millimeters of the periosteal surface and increase slightly as the endosteal region is approached. Cancellous bone has higher fluoride concentrations than compact bone. Dentine and bone appear to have similar fluoride concentrations which increase with age. while that of enamel is markedly lower.

The fractional retention or balance of fluoride at any age depends on the quantitative features of absorption and excretion. For healthy, young, or middle-aged adults, approximately 50 % of absorbed fluoride is retained by uptake in calcified tissues, and 50 percent is excreted in the urine. For young children, as much as 80% can be retained owing to increased uptake by the developing skeleton and teeth .Such data are not available for persons in the later years of life, but based on bone mineral dynamics, it is likely that the fraction excreted is greater than the fraction retained.

Surface enamel fluoride concentrations tend to decrease with age in areas subjected to tooth wear but increase in areas that accumulate plaque. Dentine fluoride levels decline progressively from the pulpal surface to the dentine-enamel junction (DEJ). Enamel fluoride concentrations are highest at the surface and decline progressively toward the DEJ. Bulk enamel fluoride concentrations mainly reflect the level of fluoride exposure during tooth formation, while dentine and bone fluoride concentrations are generally proportional to the long-term level of intake.

3-Fluoride Excretion

a-Urine

Fluoride is excreted primarily via urine . The percentage of the filtered fluoride reabsorbed from the renal tubules can range from about 10 to 90 %. The degree of reabsorption depends largely on the pH of the tubular fluid, urinary flow and renal function . Urinary fluoride clearance increases with urine pH due to a decrease in the concentration of HF.

Numerous factors (e.g. diet and drugs) can affect urine pH and thus affect fluoride clearance and retention. The renal clearance of fluoride in the adult typically ranges from 30 to 50 ml/min. whereas clearance rates of the other halogens (chloride, iodide

and bromide) are usually less than 1.0 ml/min. The excretion of fluoride in urine is reduced in individuals with impaired renal function.

b-Feces

It is generally accepted that most of the fluoride in the feces is not absorbed. Fluoride present in feces results from two sources: the ingested fluoride that is not absorbed and the absorbed fluoride that is re excreted into the gastrointestinal tract .Fecal fluoride usually accounts for less than 10 percent of the amount ingested each day.

c- Sweat

Usually, only a few percent of the fluoride intake is excreted in the sweat. However, under excessive sweating as much as 50 % of the total fluoride excreted may be lost via perspiration.

d- Breast milk

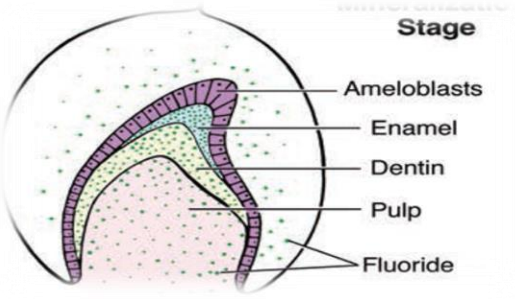
The average fluoride level is 0.019±0.004 ppm in breast milk, fluoride intake of infants is not very high.

e-Saliva

Less than 1 percent of absorbed fluoride is reported to appear in the saliva. The concentration of fluoride in saliva is about two-thirds of the plasma fluoride concentration and seems to be independent of flow rate, in contrast to the situation for most electrolytes. Fluoride presents in saliva in low concentration 1-2µmol/L which is from toothpaste , water, and food.

In fact, saliva does not represent true excretion, because most of the fluoride will be recycled in the body. However, the fluoride content of the saliva is of major importance for maintaining a fluoride level in the oral cavity.

Fluorides during tooth development

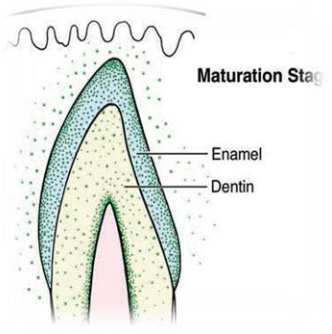


I.preeruptive: mineralization stage

Fluoride is deposited during the formation of the enamel, starting at the dentinoenamel junction, after the enamel matrix has been laid down by the ameloblasts. Fluoride is incorporated directly into the hydroxyapatite crystalline structure during mineralization of all the parts of the teeth to become of fluorhydroxyapatite which is less acid soluble than hydroxyapatite. Preeruptive

fluoride also results in alteration in tooth morphology by development of shallower occlusal grooves, reducing the risk of fissure caries.

II. Preeruptive: maturation stage:



After mineralization is complete and before eruption, fluoride deposition continues in the surface of the enamel. Fluoride is taken up from the nutrient tissue fluids surrounding the tooth crown. Much more fluoride is acquired by the outer surface during this period than in the underlying layers of enamel during mineralization.

III. Posteruptive

After eruption and throughout the life span of the teeth. The concentration of fluoride on the outermost surface of the enamel is dependent upon topical sources of fluoride from fluoridated drinking water, dentifrices, mouthrinses, and other surface exposures. The fluoride on the outermost surface is available to inhibit posteruptive demineralization. Fluoride in the oral fluids, including saliva and dental plaque, also contributes to the cariostatic effect. This posteruptive effect is due mainly to reduced acid production by plaque bacteria and to an increased rate of enamel remineralization during an acidogenic challenge.