Fluorides in Dentistry

For over 60 years, dental professionals have been attempting to control caries with fluoride. The buildup of fluoride in the mineralized tooth tissues during tooth development was thought to render them more resistant to the effects of plaque acids. 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. Fluoride appears to provide its benefit when present in the oral cavity. Its effectiveness depends on how frequently it is administered in the mouth. Fluoride can be used to increase the resistance to dental caries while minimizing the risk of fluorosis via maximizing topical exposure of fluoride throughout life and minimizing systemic absorption during the developing period of dentition.

The beneficial effects of topical fluoride application were first seen as a result of daily exposure to very low concentrations of fluoride by means of the drinking water or diets enriched in fluoride in the addition of fluoride to toothpastes and mouth rinses with concentrations of fluoride higher than fluoridated water.

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 Environment:

Fluorine is never seen in nature in the elemental form because of its the most electro negative of all chemical elements. Its 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 (ionic compound CaF_2). Thus, fluoride is the term used when fluorine is combined chemically with a positively charged counterpart. The complexes often consist of crystalline ionic salts such as fluorapatite ($Ca_{10}[PO_4]6F_2$).

Fluorine is one of 118 chemical atomic elements in the periodic system. In its pure form, it is a poisonous pale yellowish brown gas.

In soil: Fluoride concentration of soil increases with depth. In high mountain areas the fluoride content of the soil is usually higher. In rock and soil, fluoride may occur in a wide variety of minerals, including fluorspar contains calcium fluoride, cryolite contains aluminum fluoride.

✓ **In waters:** water with high fluoride content are usually found at the foot of high mountains. All water contains fluorides in varying concentrations .As many of the minerals in the soil are soluble in water, fluoride is found in varying concentrations in the groundwater, 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.

✓ **In atmosphere:** fluoride 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 Metabolism

Fluoride intake: The major sources of fluoride are

1. Food► Most foods have fluoride as fish.

2. Liquid► drinking water and beverages, tea contains up to 7 ppm.

3. Fluoride-containing dental products.► tooth paste, fluoride gel

Absorption of fluoride:

Approximately 75 -90 % of the fluoride ingested each day is absorped from the alimentary tract. 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 whereas compound with solubility such as CaF2, MgF and A1F3 , are less completely absorbed. So the presence of Ca may lead to formation of insoluble salts with fluoride and absorption reduced to 70% and in food rich with Ca to 60%. 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.

Distribution of Fluoride in the Body

1. 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.

There are two general forms of fluoride in human plasma. The ionic form (also called as inorganic fluoride or free fluoride) and the non ionic or bound fluoride. Ionic form is of significance in dentistry and public health and is detected by ion-specific electrode. Together the ionic and non ionic fraction is called “total” plasma fluoride. 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. Since plasma fluoride levels are not homeostatically regulated, there is no „normal“ physiologic concentration. Plasma fluoride levels increase with age. Fluoride balance in infants can be positive or negative during the early months of life, depending on whether intake is sufficient to maintain the plasma concentration that existed at the time of birth.

2. Fluoride in Soft Tissue

The intracellular fluorides concentrations are from 10–50 % lower than those of plasma, but they change simultaneously and in proportion to those of plasma. The tissue-to-plasma ratios of radioactive fluoride are consistent with the hypothesis that hydrogen fluoride (HF) is the form in which fluoride migrates and establishes diffusion equilibrium across cell membranes. Since the pH gradient across the membranes of most cells can be decreased or increased by altering extracellular pH, it is possible to promote the net flux of fluoride into or out of cells. This is the basis for the suggestion that alkalinization of the body fluids is a useful adjunct in the treatment of acute fluoride toxicity.

3. Fluoride in Calcified Tissues

Approximately 99 percent 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. Cancelous 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. 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 (all the enamel from a tooth) 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.

Fluoride Excretion

1. In Urine

Fluoride is excreted primarily via urine. Fluoride is freely filtered through the glomerular capillaries and then undergoes a variable degree of tubular re-absorption. The percentage of the filtered fluoride reabsorbed from the renal tubules can range from about 10 to 90 percent. 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. Among the halogens, the renal clearance of fluoride is unusually high. 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.

2. In Feces

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

3. In Sweat

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

4. In 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. 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.