

In the name of God

shiraz university of medical sciences

school of dental medicine

THESIS:

FOR D.M.D Degree

FLUORIDE AND DENTAL FLUOROSIS AND TREATMENT

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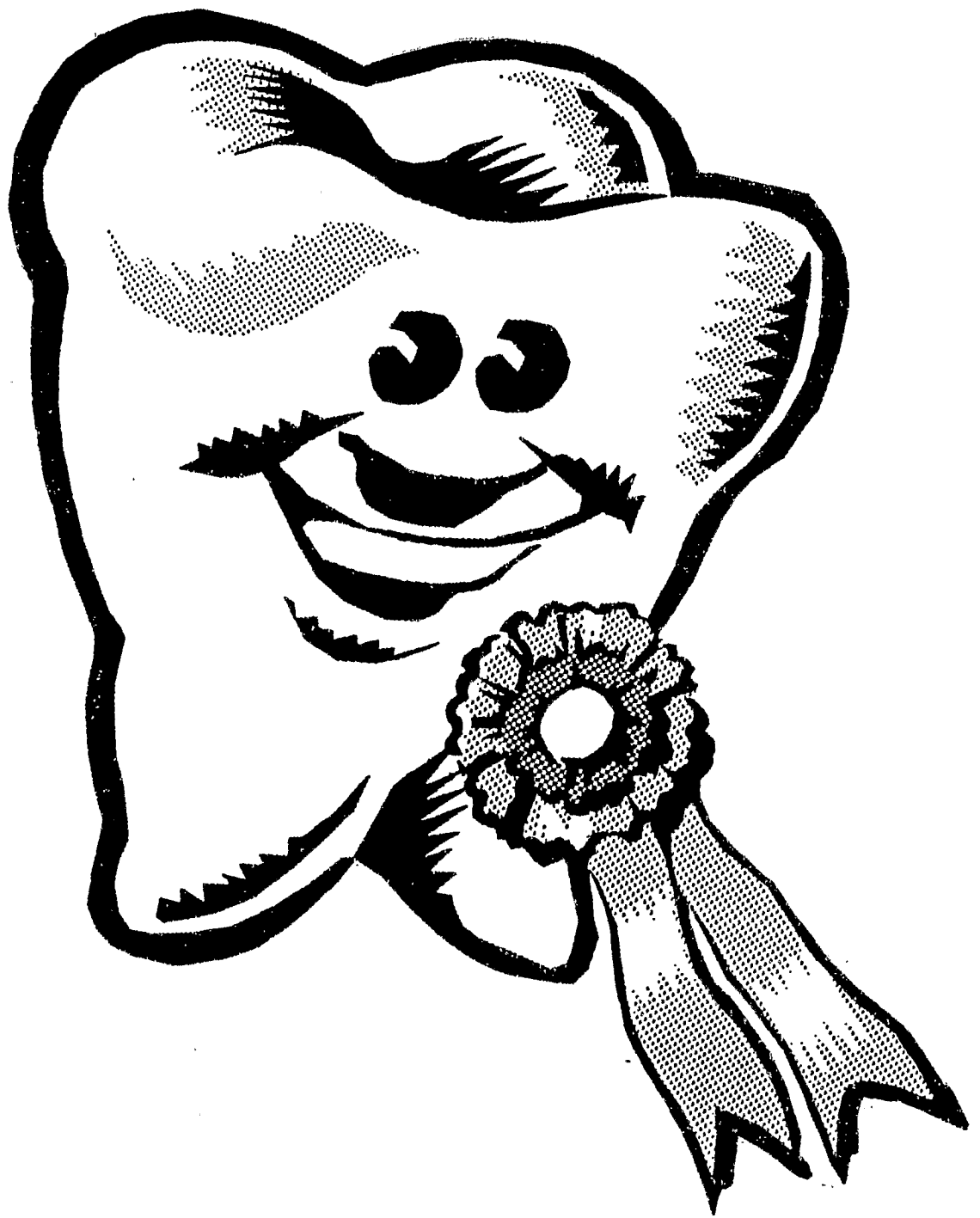
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۱۳۷۶ / ۵ / ۲۵

May- 1997 ( 1376 )

۱۳۷۶ / ۵ / ۲۵



تقریم به پروردگارم که در راه شکر و تعظیم زینت آن خود ملا فراموش کرد تا میوه آنها به بر شیند و بر موفقت  
ملا چشمه اشکبار و بخت خسته در حالات خوبت کنند، لیکن پایت نامه تقریر است را بر قدر دل از جگر

تقریم به مکه که وصف فراکار و مختار بود در دوران دانشجویم امکان نیست و از جائق و همکار صمیمی به پیش  
در تیره این پایت نامه پس ملا دارم و امید دارم که نتیجه تلاشم تقریر باشد بر صلیب فراکار باش

تقریم به خواجه امان عزیزم که موفقت در کتب علم و دانش و سعادت و شجاعت آنها نهایت آرزو قلب من است

تقریم به میوه زینت که در جهم شادتر است

تقریم به تمام عزیزانم در همواره موفقت من در امر زکری و تحصیل علم بودند و با بلای من یاری

نوشته محرابی دادند

## با سپاس و تقدیر از:

- استاد ارجمند آقای دکتر مهران معتمدی بخاطر تلاشهای بی‌شائبه ایشان در تهیه،

تنظیم و هدایت این بیان‌نامه.

- استاد گرامی آقای دکتر علوی بخاطر قبول داوری و ارائه‌های سودمند ایشان

در طی دوران تحصیلاتم.

- استاد گرامی خانم دکتر خجسته پور که در کسب علم و هنر این حرفه و قبول

داوری مرا یاری نموده‌اند.

- آقایان سعید و مجید بیوسفی که صمیمانه در تایپ، تکثیر و صحافی این بیان‌نامه

همکاری نمودند.

- آقای مهندس علی مهدوی که در طراحی اشکال کامپیوتری این بیان‌نامه مرا

یاری نمودند.

- آقای همتا که با هنر خطاطی خویش این بیان‌نامه را مزین نمودند.

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# Introduction

In the early years of this century, attention was drawn to the occurrence of " mottled enamel" , an abnormality in which the enamel, usually only of the permanent teeth, acquired an unsightly brown pigment. It became clear that mottling occurred only in people born and spending their child-hood in certain areas coinciding with those of water supplies and that a constituent of the water was responsible for the condition .

An analysis by routine methods failed to detect any constituent common to water supplies which caused mottling , but in 1931-25 years after the search began-fluoride was found in a number of these water supplies. Almost simultaneously it was found by smith et a. (1932) that when fluoride was added to rat's diet, the effects on their teeth were similar to those produced by adding water from areas where mottling occurred, which strongly supported the view that fluoride was the element responsible.

Thus in the following chapters we first study properties of fluoride and then dental flourishes that is caused by chronic fluorine intoxication.(14)



# PART 1

Properties of fluorine

## **Fluorine**

Non metallic halogen element in group VIIA of the periodic classification. Atomic number 9. Atomic weight 18.9984; valence 1. No stable isotopes. The most electronegative element and the most powerful oxidizing agent known.

Forms fluorides with all elements except helium, neon, Argon. widely distributed to the extent of 0.03% of the earth's crust. the chief minerals are fluorapatite, cryolite, and fluorspar. (9)

Fluorine is an element that virtually never occurs naturally in it's free, gaseous form. In the form of fluorides, however, it is one of the most plentiful and wide spread of elements, standing seven teenth in order of abundance in the earth's crust. (24)

## **Fluoride Intake**

### **Dietary source of fluoride**

Most fluoride intake by human is oral. The amounts of fluoride in haled are negligible, except for rare and very specific exposures in the work place (smith and Ekstrand, 1988) Applying micro diffusion and the fluoride-specific electrode, we measured the fluoride in food , water, and beverages of German origin, and calculated the data presented in table 1 (Taves, 1968); Singer and Ophaug, 1986). The data present total fluoride intake from natural sources in areas where drinking water is low in fluoride, excluding supplements of any kind. (2)

Fluorides occur in water, soil , rocks, dusts, volcanic gases and the atmosphere. They are also present in most foods, many plants an virtually all animal tissues. (24)

The total intake from solid food is relatively small, and amount to only about 0.5 to 1.0 mg/day in Britain. High concentration in fish are often quoted but because the fluoride is mainly in the bones and skin its importance as a source of dietary fluoride has been exaggerated. Tea contains more fluoride than any other dietary item. (31)

The only two common dietary constituents high in fluoride are fish and tea.(19)

Fluoride of Milk: Most of the published figures suggest that the free ionic fluoride is below 0.01 ppm, but that if the Milk is ashed or treated with strong acid the fluoride detected is about six times greater. It is assumed that the bound fluoride is probably associated with the calcium salts of the milk and is released during digestion.

#### *Non- dietary source of fluoride:*

In addition to dietary sources, most people in developed countries have in the past few years been exposed daily to extremely high concentrations of fluoride as tablets, toothpastes, mouth rinses and , less frequently, to topical applications as solutions or gels. With adult and older children little of fluoride from these sources is swallowed, but children younger than 4 years old are often unable to clear their mouths by rinsing and spitting and much of the fluoride is swallowed. However there is danger of over-dosing, leading to some fluorosis, especially if tooth pastes are used along with other measures such as tablets or fluoridated water.

It is strongly recommended that young children should use either tooth pastes low in

fluoride (500 ppm) and/or use a smear of tooth paste no larger than a pea. (19)

**Table 1**

*Mean fluoride intake of children and adults in Germany from natural sources (Berg mann, 1995)*

Age(years)	Fluoride mg/day	Intake mg/kg/day
1- 109	0.112	0.011
4- - 509	0.203	0.010
8-909	0.227	0.008
15 - 18 f	0.470	0.009
15 -15 m	0.523	0.008
adult f	0.442	0.007
adult m	0.560	0.007

f:femal

m:male

Recent research shows that fluoride mouthrinses are proven cariostatic agents that recieved approval by the U.S food and Drug Administration in 1974 and cceptance by the American Dental Assgciation in 1975. Fluoride mouthrinsing is one of the most widely usee caries preventive public health methods. In the United States, It is second only to community water fluoridation. The exact number of American children participating in shcool-based fluoride mouthrinsng programs is not clear, and the figure has been reported to be as low as 2-4 million and as high as 12 million. the availability of over the counter products has increased the use of fluoride mouthrinses by children and adults. several fluoride compounds. Fluoride ion concentrations , and rinsing frequencies have been tested in more than three dozen clinical trials. However, two regimens have been adopted as standard for individual programs of patient care or for school -based programs. Respectively, these are a 0.05 percent NaF rinse (230 ppmF) (also a 0.044 percent APF rinse) used daily and a O.2 percent NaF rinse (900 ppmF) used weekly or fortnightly. (25)

Fluoride gels are either operator-or self-applied. The fluoride compounds used in these products are neutral sodium fluoride (NaF), acidulated sodium fluoride (APF), or stannous fluoride (SnF) the fluoride concentrations are higher in the operator -applied products. Operatar- administered fluoride gels are applied with trays, self-applied gels use either a trayor toothbrush. (25)

For the fluoride from dentifrices to affect the development of tooth enamel, it must be absorbed. Although fluoride absorption from tooth pastes has been reported to be nearly 100 percent, If.the dentifrice formulation contains a calcium abrasive, or if mild has been recently consumed, fluoride absorption form either sodium fluoride or sodium mono fluorophosphate may be reduce significantly. Several mono fluorophosphate dentifreices marketed in teh U.S. contain clacium compounds as abrasive e.g., colgate with MFP, Macleans, and Aqua-Fresh, and for these pastes, the amount absorbed may be less than the amount retained or ingested.(25)

However for those methods discussed that have recieved sufficient clinical testing, the relative caries reduction should approximate 30 percent, regardless of the baseline caries activity. (25)

Researches from carolina shows : How ever, little is known regerding fluoride intake from beveages in a sample of children of ages susceptible to dental fluorosis. The purpose of this study was to estimate the amount of fluoride ingested from beverages by a sample of North Carolina (NC) children of ages 2-10 years. Data on beveage consumption were collected by means of a diary format.

A questionnaire was included so that demographic information and self assessment on the accuracy of the diaries could be obtained. Beverages reported in the diaries were purchased and their fluoride content was assayed.

Daily total fluid intake ranged from 970 to 1240 ml. and daily beverage consumption ranged from 585 to 750 ml. The estimated mean daily fluoride intakes from beverages for children 2-3, 4-6, and 7-10 years of age were 0.36, 0.54, and 0.60 mg, respectively (22)

Table . 2

*Fluoride content (ppm) of Beverages By Type*

Beverage	N	Mean	SD	Min	Max
Sadas	105	0.74	0.28	0.07	1.37
Juices	70	0.36	0.38	0.01	1.70
Punches	41	0.33	0.43	0.00	1.44
Tea	26	2.56	1.26	0.61	6.68
Gatorade	13	0.85	0.27	0.02	1.04
ALL	255	0.76	0.82	0.00	6.68

## **Absorption & Excretion of fluoride**

### **Absorption of fluoride:**

Fluoride is absorbed by a passive process from the alimentary tract. Radioactive tracer experiments have shown that maximum plasma levels are reached within an hour of ingesting 1 mg of fluoride. Calcium and magnesium in relatively large amounts have been shown in experiments to bind fluoride, but the amounts present in even the hardest water in Britain do not appreciably reduce .

the absorption of fluoride present in water at a level of 1 mg/litre .(24)

absorption of fluoride is also accelerated when administered with lipids. The absorption of fluoride also depends on the condition of the body and also depends on the acid base equilibrium in the body. (8)

Absorption from the mouth, as elsewhere, is greatly accelerated when the PH is reduced because it is non-ionized HF, and not fluoride ions, that can permeate cell walls. This explains why fluoride, unlike most nutrients, is absorbed largely from the stomach, where the HCL of the gastric juice will lead to the formation of HF and may in favourable circumstances, such as an empty stomach, convert almost all the fluoride into HF. In presence of calcium, as in experiments with calcium fluoride or dietary bone meal, absorption is greatly reduced as the calcium salts have a very low solubility and, even if dissolved in the stomach, would probably precipitate in the intestine as the PH rises. Ingestion of aluminium also reduces fluoride absorption probably by forming complexes that make less fluoride available for converting into HF.(19)

Absorption seems to take place from various portions of the gastrointestinal tract, that is the stomach and the small intestine. The studies have demonstrated that over 80 percent of soluble fluorides may be absorbed in 90 minutes.(20)

Once absorbed into the body fluids, two major mechanisms reduce the fluoride concentration in the circulating body fluids :

Deposition in the skeleton

Excretion in the urine. (20)

### **fluoride Excretion:**

The three main avenues for the elimination of fluoride from the body are the urine, feces and perspiration. Saliva may serve as another mode of excretion, but it is swallowed and thus recycled.(20)

The principal route of fluoride excretion is via the urine and the urinary fluoride level is widely regarded as one of the best indices of fluoride intake. The clearance of fluoride by the kidney is less than that of inulin, which indicates that some of the

fluoride filtered through the glomerulus is reabsorbed by the tubuls. Between 35% and 45% of the fluoride is reabsorbed in the proximal tubul, but if the PH of the fluid in the distal tubule falls, more reabsorption occurs as the fluoride ions are converted into HF, the form in which fluoride is diffusible into cells. In an individual relatively unexposed to fluoride, about half a single dose of fluoride is excreted in the urine in the following 24hr. and about half is deposited in the skeleton. (19)

The proportion of absorbed fluoride excreted in the urine depends on the extent of retention by the bones and teeth. This in turn is affected by age and the previous intake of fluoride. (24)

In infants as much as 90% of the fluoride intake may be retained. This proportion decreases with age. In older children and adults, more than 90% of the fluoride ingested is excreted via the urine, and only minor proportions are retained in the skeleton. urinary fluoride excretion reflects total fluoride intake. Table 3 shows urinary fluoride concentrations of infants and 5 year-old children with and without fluoride supplements. (2)

**Table. 3**

*Fluoride concentration (mg/kg) in urine samples of 109 infants with a fluoride supplement of 0.25 mg/day or without supplement, and of 80 children with supplements of 0.325 (+0.133) mg/day or without supplement.*

Age	Fluoride yes	Supplement No
4 weeks	0.084 (0.098)	0.017 (0.015)
8 weeks	0.097 (0.096)	0.018 (0.017)
12 weeks	0.141 (0.168)	0.016 (0.020)
26 weeks	0.220 (0.172)	0.063 (0.071)
5 years	1.371 (0.858)	0.563 (0.299)



## Storage of Fluoride

### Fluoride in Blood:

Approximately three quarters of the fluoride in Blood is in the plasma, and plasma levels of 0.14 to 0.19 mg/litre are maintained by urinary excretion and skeletal deposition over a wide range of fluoride intake. Only about 15 to 20 percent of plasma fluoride is free and ionic, the remainder being non-ionic and bound to albumin. (24)

It is now agreed that in areas with water containing less than 0.25 ppm F, The mean concentration of fluoride ions in blood is about: 0.5 mmol/L (0.01ppm). When F is added to blood, about one-quarter of it enters the red cells. When the CO<sub>2</sub> tension of the blood is raised, an "F shift" from the plasma into the cells occurs similar to the chloride shift but with a different explanation: a rise in CO<sub>2</sub> tension lowers the PH of the plasma thus increasing the formation of HF, the form which can permeate cell walls. (19)

Although the plasma fluoride is not nearly as static as was once thought, the rapid rise after ingesting a few mg of fluoride lasts only for an hour or so, even if the basal value is not reached for several hours. A mechanism must exist therefore for the rapid elimination of most of an absorbed dose. One mechanism is uptake by the skeleton-especially the young, growing skeleton which, being low in fluoride, has greater capacity for taking it up.

In older people, the bone fluoride is higher and the plasma approaches equilibrium with it, hence the rise in plasma fluoride with advancing years. Another Mechanism for lowering the plasma fluoride is the rapid excretion by the kidney.(19)

### Fluoride in soft tissues:

The mineralized tissues are the main site of storage of fluoride and contain about 99% of the total. Analysis of healthy soft tissues invariably gives low values for fluoride and their validity is confirmed by study of the ratio between the concentrations in the tissues and the plasma (the T/P ratio) after the injection of F. This ratio was found to be less than 1.0 in all tissues except two -the kidney (with its concentrate of glomerular fluid) and bone with T/P ratios of 4.16 and 7.5, respectively the lowest was brain (0.084), suggesting that fluoride does not readily cross the blood- brain barrier, followed by adipose tissue, presumably low from its poor vascularity. A high fluoride concentration in a soft tissue suggests that it is undergoing pathological mineralization (19)

The fluoride concentration in human milk and saliva is 0.05mg/litre or less. The concentration in other soft tissues is usually less than 1mg/kg except in tissues such as the aorta, and the placenta in late pregnancy which may contain high levels. (24)

## Fluoride in hard tissues

### A- Bone :

Because fluoride ions can enter the hydroxy apatite lattice, the concentration in human bone builds up slowly with age, its concentration depending on the fluoride intake.(19)

The incorporation of fluoride slightly alters the chemical composition of bone and tooth mineral; the carbonate and citrate contents are lowered and the magnesium level increased. The Ca/P ratio, however, remains unchanged. If the intake of fluoride is markedly reduced, some of the fluoride accumulated by bone is gradually lost.(19)

The concentration is higher in the areas of active growth, near the endosteal and surface, than in the central parts of compact bone. (24)

In addition to age, the main factor controlling the fluoride of bone is the fluoride intake, which means in practice the fluoride concentration of the drinking water and the amount of tea consumed. (19)

### B- Teeth :

Fluoride concentration in teeth is lower than in bone and the increase that occurs with age is less marked. As with bone, it is influenced by the fluoride level in drinking water. (24)

After the tooth has fully formed fluoride is chiefly incorporated at tissue surfaces and its concentration in dentin is highest adjacent to the odontoblastic layer. In deeper layer. (24)

## Enamel:

As in bone the distribution of fluoride in the dental tissues are formed is not uniform. The gradients are present in unerupted teeth and presumably arise because after the full thickness of the enamel is formed it remains in contact with tissue fluid for , in some teeth, several years before eruption .

The capacity for apatite to bind fluoride is so great that it was at first assumed that fluoride entered enamel and other calcified tissue because it became bound to the high concentration of apatite that they contain. Fluoride of inner enamel was deposited with the protein during the secretory stage and was either diluted by the influx of more mineral or partly removed, along with the protein during maturation. In the very last stage of post eruptive development, the fluoride of the enamel rose slightly, probably because the surface layer was already highly mineralized and could take up fluoride from the tissue fluid.(19)

## Dentin:

The fluoride concentration in dentine are two to three times higher than those of enamel and its distribution is the reverse: The inner dentin close to the vascularized pulp contains higher concentrations than the outer layers near the amelodentine junction. The concentration increases steadily with age, presumably because fluoride in tissue fluid diffuses along the dentinal tubules and is taken up by the apatite.(19)

## Cementum:

The fluoride concentration in cementum in the outer layer usually has the higher concentration with a steep fall in the inner layers, but in a few teeth the highest concentration is some distance infrom the outer layer. There is usually a sharp fall in the boundary between the outer acellular cementum and the inner cellular tissue which forms more quickly. (19)