PREVENTIVE DENTISTRY

Topical Fluoride Therapy

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Topical fluorides can be used at home or applied by professional in the clinics, they advocated for home use contain comparatively less amount of fluoride and are used daily or regularly. Professionally applied fluoride agents contain very high amount of fluoride and are applied less frequently, majority being biannually.

Unit cell of hydroxyapatite showing the central ion ,the hydroxyl ion has been replaced with a fluoride ion. The main composition of enamel

1-Phosphate: The dry weight of phosphate in the enamel is 16–18% and 12% in the dentine. Phosphate deficiency is commonly not due to insufficient supply, but due to other causes, such as vitamin D-resistant rickets.

2- Calcium The dry weight of calcium in the enamel is 34– 40% and in the dentine 26–28%. To affect the teeth, the calcium deficiency must be extreme.

The combined action of parathormone, calcitonin and vitamin D maintains calcium and phosphate blood levels very stable, even when the mineral intake is suboptimal. When the bone shows signs of deficiency, the enamel will be normal, but the dentine seems more vulnerable.

3-Trace elements Magnesium (0.4% dry weight of the dentine and the enamel) appears essential in odontogenesis, but teeth with higher levels of magnesium are more vulnerable to caries.

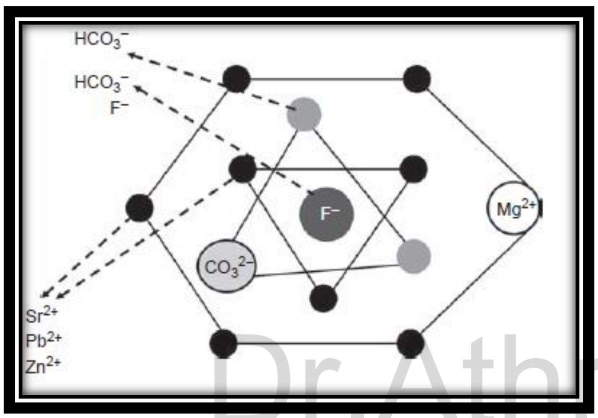
Insufficient iron causes enamel hypoplasia through enzyme damage.

Other trace elements (which are not similarly distributed within the enamel and dentine) include: zinc, silica, and to a lesser degree copper, chromium, manganese, molybdenum and tin.

Very small quantities of selenium, vanadium and cobalt are also present.

Their importance in odontogenesis is largely unknown.

Strontium in the crystal lattice may cause diffuse opacities.



The crystal chemistry of apatite

$$Ca10(PO4)6(OH)2 + Mg^{++} = \text{magnesium whitlockite}$$

$$Ca10(PO4)6(OH)2 + CO3^{-} = \text{carbonated apatite}$$

$$Ca10(PO4)6(OH)2 + 2F^{-} = Ca10(PO4)6(F)2 + 2(OH^{-})$$

(fluorapatite)

Development of Enamel caries

Caries lesion progression is highly dynamic process characterized by alternating periods of dissolution and redeposition of minerals in the dental hard tissue.

When outcome of these processes overtime is a net loss of mineral,a caries lesion develops or progresses.

PHYSICAL AND MICROSCOPICFEATURES OF INCIPIENT CARIES

The development of a carious lesion occurs in three distinct stages .

The earliest stage is the incipient lesion,which is accompanied by histologic changes of the enamel.

The final phase of caries development is the overt, or frank, lesion characterized by actual cavitation of the tooth surface— a "cavity"

The changes include demineralization, which, simply put, is loss of calcium, phosphorus, and other ions from the enamel.

The second stage includes the progress of demineralization toward the dentinoenamel junction (DEJ), the boundary between the dentinal layer of the tooth and the enamel layer. Demineralization can then continue into the softer, less mineralized dentin toward the dental pulp.

COMMON SITES OF OCCURRENCE OFINCIPIENT LESIONS

1. White spot lesions are most frequently detected on the accessible cervical third of a tooth. They are also commonly located in high susceptibility areas, such as pits, fissures, and some smooth surfaces of teeth and seen on root surface of the tooth.

2. Studies in patients with prosthodontic restorations suggest that they may have incipient caries in cervical margins.

3. Carious white spots are commonly seen on vestibular tooth surfaces after orthodontic treatment with multibonded appliances

<u>Spot White caries (initial lesion)</u>

The mineral loss makes the lesion visible as a “white spot” after blowing air on the tooth surface in the earliest phase of caries development; this is because fluid within the pores maintains the translucency of the enamel.

<u>Brown spot (discoloured white spot)</u>

Later, the white spot is clearly visible without air-drying the tooth signifying an enlarged subsurface pore volume. Microcavities may develop. The pores encourage progression of the process, chiefly along the enamel prisms and the lines of Retzius.

During remineralisation, pigments from dietary components may become incorporated into the lesion. The white spot then becomes a *brown spot*

<u>The zones seen before complete disintegration of enamel are: 10-100 micron</u>

<u>Zone 1: Translucent zone,</u>

-lies at the advancing front of the lesion,

-slightly more porous than sound enamel,1%

-it is not always present

<u>*Zone 2: Dark zone, 95% occur in lesion</u>

- this zone is usually present and referred

to as positive zone,2-4% pore vol.

-formed due to demineralization.

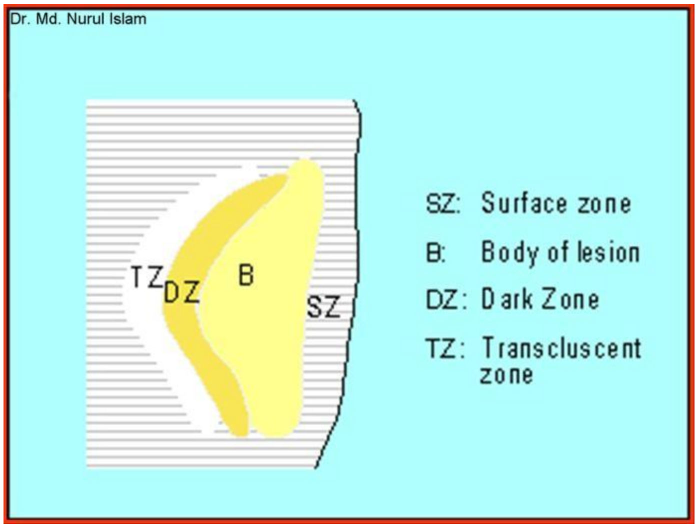
<u>Zone 3: Body of the lesion, 5%-25% pore vol.</u>

-found between the surface and the dark zone,

-it is the area of greatest demineralization,

***Zone 4: Surface zone, 0.1% pore**

-relatively unaffected area,-greater resistance probably due to greater degree of mineralization and greater F concentration.



Advantages of topical fluoride application

1. Does not cause fluorosis.
2. Cariostatic for people of all ages.
3. Available only to people who desire it.
4. Easy to use.

Disadvantages

1. Person must remember to use.
2. Per capita cost is high compared to water fluoridation.
3. More concentrated professional use products can cause short-term side effects like nausea immediately after use.

The efficacy of topical fluoride depends on:

a. The concentration of fluoride used.

b. The frequency with which it is applied and the duration of application.

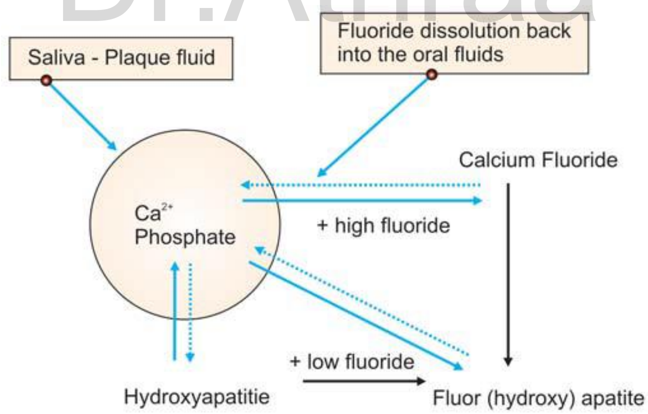
c. The specific fluoride compound used.

<u>Mechanism of action:</u>

When concentrated topical fluoride agent reacts with enamel there is formation of calcium fluoride. The presence of elevated concentration of fluoride in enamel surface makes tooth surface more resistant to development of dental caries. Fluoride ions when substituted into the hydroxyapatite crystals fit more perfectly than do hydroxyl ions. Also the greater bonding potential of fluoride makes the apatite crystals more compact and more stable, thereby more resistant to the acid dissolution.

$Ca_{10}[PO_4]_6[OH]_2 + 20F^- \leftrightarrow 10\ CaF_2 + 6[HPO_4^-]^3 + 2[OH]^-$

Hydroxyapatite   Calcium fluoride



Mechanism of action of fluoride on Enamel

<u>1-Decreases the solubility of the crystals</u>

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2- Remineralization

At pH7, saliva is supersaturated with respect to HAP. The saliva/plaque fluid contains some calcium-binding proteins (e.g., statherin) that inhibit such a spontaneous precipitation with respect to calcium phosphate salts. When the pH drops as a result of metabolic activity in the plaque, the buffers in the saliva will initially neutralize the acid (H^+). The buffers are effective in the range of pH 7.0–5.5. If the pH drops below that, phosphate ions and the hydroxyl ions will be undersaturated in the saliva/plaque fluid. Under such circumstances, HAP will become soluble at pH value around 5.5 is the critical point for dissolution of the enamel.When the pH drops below 5.5 the mineral is lost from the surface and subsurface of the enamel. However,when pH increases again to above 5.5, precipitation of HAP can take place, primarily at the surface.

Precipitation is possible because the protein inhibitors (e.g., statherin) are inactivated by the acids produced in the cariogenic plaque and are totally or partially dysfunctional.

Even with low concentrations of fluoride (<0.1 ppm),plaque is a supersaturated solution with respect to fluorhydroxyapatite (FHAP) at slightly acidic pH, down to 4.0.

Thus, when the pH drops below 5.5 (the critical point) and HAP is dissolved, FHAP is precipitated at the surface of the crystals and this continues when the pH rises again. Put differently, small amounts of fluoride, as low as 0.01–0.1ppm, in the plaque/saliva interface reduce mineral loss, as FHAP is formed at the same time as

HAP is dissolved, but also at the same time as HAP is precipitated (when the pH rises again). This precipitation or re-mineralization (repair) of both HAP and FHAP results in the outer part of the lesion being more mineralized than immediately below the surface. The evidence for this process is seen when the fluoride concentration in carious enamel is investigated and compared with sound enamel; the concentration of FAP/FHAP is significantly higher in carious enamel than in sound enamel.

Formation of Calcium Fluoride: fluoride is very reactive; when it comes into contact with dental hard tissue or the plaque/saliva fluid, fluoride will combine with calcium. The amount of calcium fluoride (CaF^2) formed is proportional to the concentration of fluoride. Consequently, the amount of calcium fluoride is larger after local application of 2% sodium fluoride than after application of 1% sodium fluoride. The calcium fluoride acts as a local depot or reservoir of fluoride that dissolves when the pH drops. The subsequently released fluoride can result in the formation of FHAP as explained above.

<u>3- Influence of Fluoride on Microbial Metabolism</u>

Fluoride can interfere with enolase, an enzyme which is used by bacteria in the fermentation of carbohydrates. Studies, however, indicate that it requires quite a high concentration of fluoride (> 20 ppm) which is not very often achieved in dental plaque. Thus, fluoride may have an influence on the metabolic activity of plaque bacteria, but the clinical effect is not likely to be significant.
Fluoride inhibits the glycolytic enzyme, enolase, which converts 2-P-glycerate to P-enolpyruvate. Enolase ,2-PGPEP

This results in the inhibition of sugar transport via the PEP phosphotransferase system (PTS). Acidic conditions outside of the cell wall of the bacteria (for example, when APF fluoride is applied) convert fluoride ions to hydrogen fluoride (HF), which is able to diffuse into the bacteria. Inside the cell, where the cytoplasm is alkaline, HF disassociates into fluoride ions and protons.

The fluoride ions inhibit metabolic enzymes and the added protons acidify the cytoplasm, causing a reduction in both the proton gradient and enzyme activity.

Dentin :De-and Remineralization

(1) Dentin is more susceptible to caries attack than enamel, with a critical pH more than 1 pH unit higher than that for enamel.

(2) Dentin demineralizes faster and remineralizes slower than enamel under the same experimental conditions.

(3) More concentrated fluoride is needed to inhibit demineralization and to enhance remineralization of dentin when compared with enamel. clinical trials show a beneficial effect of 5,000 ppm fluoride over 1,100 ppm fluoride dentifrices to arrest root carious lesions.

(4) Dentin seems to benefit from a higher daily frequency of exposure to fluoride and also from the combination of methods of fluoride use which is not necessarily the case for enamel.

(5) Dentin contact area with cariogenic acids is larger than that of enamel. For this reason, dentin is apparently much more permeable to acids, with demineralization taking place at a relatively large depth, while mineral deposition is restricted to the outer layers.

Classification

Fluorides Applied by Dentist/Professionally Applied

A. Aqueous solutions

• Sodium fluoride (NaF) - 2 %

• Stannous fluoride (SnF_2)- 8%

- Silver Diamine Fluoride (SDF)- 38%

B. Fluoride Gels

• Acidulated phosphate fluoride - 1.23 %

C. Fluoride varnishes

• Duraphat

• Fluorprotector

D. Fluoride prophylactic paste

E. Restorative materials containing fluoride

F. Fluoride containing devices (slow release)

Self Applied

- Fluoride dentifrices
- Fluoride mouth rinses.
- Fluoride gels