

## **Definition and Levels of Prevention**



### **What is Preventive Dentistry?**

Can be simply defined as the employment of all the measures necessary to attain and maintain optimum oral health .This can be achieved by different levels of prevention.

The roots of the word come from the Latin terms ‘*praevenire*,’ which means ‘to anticipate’ and ‘*dens*,’ which means tooth. Dentists and their team members are working every day to ‘anticipate’ what could happen to their patients’ teeth and supporting structures. This definition assumes that the thing being prevented is anticipated, but it does not mean that the extent, severity, or extent of the thing is always known.

Prevention in health care means action to stop ill health before it begins. In dealing with disease, **“prevention is better than a cure.”**

## **Is Preventive Dentistry still needed?**

As decay rates have been reduced, dentists turn their interest to previously underutilized therapies such as Cosmetic Dentistry, Orthodontics, third molar extractions, Implant Dentistry, and so on that need improved preventive care, on the other hand the life expectancy has increased and people are living longer and retaining their teeth which means that preventing root caries, periodontal disease, and oral cancer will be even more important than before. The frail elderly is the fastest growing segment of the population, and they will need even more preventive care because of their increased risk for disease.

Dental disorders are an enormous burden to society, especially when considering the connection between poor oral health and systemic illness

### **Levels of Prevention:**

**1- Primordial Prevention:** It is the prevention of emergence or development of risk factors (beginning with change in social and environmental conditions) in countries or population group in which they have not yet appeared. Individual and mass education is main intervention method in primordial prevention.

**2- Primary Prevention (Pre-pathogenesis):** It is defined as 'action taken or information given prior to the onset of the disease, which removes the possibility that a disease will even occur'. It is carried out on healthy populations, Information and / or public health measure for the whole population may be sufficient to maintain a disease free environment, this is the goal of primary prevention so we can anticipate and prevent the occurrence of the disease altogether. It is divided into health promotion and specific protection.

**A-Health Promotion:** It is process of enabling people to increase control over and to improve health. This can be achieved by

- Health education; instruction on proper plaque removal, daily tooth brushing and flossing
- Environment modification such as safe water, control of insects
- Nutritional interventions: improvement of nutrition in vulnerable group.
- Lifestyle and behavioral changes; which favor health.

**B- Specific Protection:** These are activities designed to protect against disease agents by decreasing the susceptibility of the host or by establishing barrier against agents in the environment. Methods include immunization, use of specific nutrition, avoidance of allergens, protection from carcinogens, the use of fluoridated toothpaste and application of pit and fissure sealants.

**Secondary Prevention (Pathogenesis: Initial Stage of Pathogenesis):**

Can be defined as ‘actions which halts the progress of a disease at its incipient stage and prevents complications’. The focus of secondary prevention is early disease detection, making it possible to prevent the worsening of the disease and the emergence of symptoms, or to minimize complications and limit disabilities before the disease becomes severe. Secondary prevention suggests when the disease is just starting, and returning the subject to good health.

For example Secondary prevention includes the detection of disease in asymptomatic patients with screening or diagnostic testing and preventing the spread of communicable diseases. Other example include when incipient enamel lesions(white spot enamel lesions) can be arrested and reversed using appropriate ‘preventive’ measures and are reversed before

cavities form, other example gingivitis can be reversed before periodontitis sets in, it was well established that frequent oral hygiene reinforcement by dental professionals can prevent caries, gingivitis

Secondary prevention of oral cancer could include identification of dysplastic tissue and its removal as well as stopping the irritation that leads to the dysplasia. When dysplasia is found and excised before cancer develops, thus returning to good health and controlling dental disease is possible. To prevent oral cancer, alternatives to biopsies used for early detection and surgical removal are only now being explored.

### **Tertiary Prevention (Pathogenesis: Late Stage of Pathogenesis):**

Actions taken when the disease process has advanced beyond its early stages i.e. intervention in late pathogenesis phase. It can be defined as ‘all measures available to reduce or limit impairments and disabilities, minimizing suffering caused by existing departures from good health and to promote the patients adjustment to irremediable conditions’. The goal of tertiary prevention is to reduce the negative impact of an already-established disease by restoring function and reducing disease-related complications (prevent further complications or death). Tertiary prevention also aims to improve the quality of life for people with disease.

**Rehabilitation:** It is “the combined and coordinated use of medical, social, educational, psychological and vocational measures for training and retraining the individual to the highest possible level of functional ability.” Eg. Special schools for blind pupils, provision of aids for crippled, reconstructive surgery and modification of life for cardiac patients.

**In Dentistry**, tertiary prevention measures include replacement of missing teeth with bridges, implants, or dentures.

### **Caries prevention: how far it had come in one century!**

When the disease has progressed significantly and more drastic measures are required (such as root canal therapy), one is still ‘preventing’ tooth loss. This was the goal in the early days of dentistry more than a century ago when Dr. G.V. Black proposed the “Extension for Prevention” concept during the restoration of teeth

It has taken over a century for dentistry to advance from the pioneering “extension for prevention” concepts proposed by Dr. G.V. Black. By removing a significant proportion of tooth structure so that only the easily cleansed tooth surfaces remained, there was a reduction in the need for further operative treatment. As dental decay rates began to fall worldwide in industrialized countries after Second World War, a new concept of operative dentistry began to take hold. It is called **Minimal Intervention Dentistry (MID)**, as the term suggests, refers to a principle of treatment in dentistry in which early intervention minimizes tooth destruction because the disease is diagnosed prior to cavitation, and steps are taken to remineralize the enamel and arrest the decay. However, more than that assessing caries risk can be done in several ways using many different approaches include:

A thorough analysis of patient history (social, medical, and dental), followed by a careful extra- and intraoral examination will provide the necessary background for assessing caries risk in order to determine the most appropriate preventive therapy. Changing dietary patterns, controlling the cariogenicity of the oral microflora, and providing a healthy environment for remineralization are primary goals.



### Rational for using Topical Fluoride Agents

Over a period of few years the concentration of fluoride at the enamel surface increase above the initial concentration of the eruption time ,this is due to the uptake of the fluoride by the enamel present in the salivary environment and this in turn by the fluoride concentration ingested from water and foods, this process may be viewed as a continuation of the maturation process and is important as a defense contribution against enamel caries , so the rational for using topical fluoride **is to speed rate and increase the concentration of fluoride acquisition over the level which occurs naturally**, if an individual is exposed post eruptively it may take years before surface enamel acquires an effective concentration, topical fluorides hastens this process, since immature and porous enamel acquires fluoride rapidly and since erupted teeth undergo a rapid maturation so the best time to apply topical fluoride is soon after eruption also the initial caries lesion, is characterized by white spot which is porous and accumulates fluoride at a much higher concentration than the adjacent sound enamel. This implies that periodic application would enable vulnerable enamel sites that are partially demineralized to accumulate fluoride .

**The term topical fluoride therapy is to the use of systems containing relatively large concentrations of fluoride that are applied locally or topically over a relative short period of time, to the erupted**

tooth surface to prevent the formation of dental caries. Application of topical fluorides immediately after eruption hastens fluoride uptake and makes enamel more resistant to dental caries.

**Advantages of Topical Fluoride:**

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

**Disadvantages of Topical Fluoride:**

1. Person must remember to use.
2. High cost 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.

**Topical Fluoride administration could be applied through.**

**1. Those applied by professional.**

- a. Topical solutions and gels and foams
- b. Fluoride containing varnishes.
- c. Fluoride prophylaxis paste.
- d. Restorative materials containing fluoride.
- e. Fluoride containing devices (Slow Release).

## **2. Self-applied fluoride agents.**

- a. Fluoride dentifrices.
- b. Fluoride rinses.
- c. Fluoride gels and foams.

### **Classification of Topical Fluoride:**

#### **Fluorides Applied by Dentist/Professionally Applied**

##### **A. Aqueous solutions**

- Sodium fluoride - 2 %
- Stannous fluoride - 8%

##### **B. Fluoride Gels and foams**

- Acidulated phosphate fluoride - 1.23 %

##### **C. Fluoride varnishes**

- Duraphat ( NaF 2.26 % ) 5% sodium fluoride (NaF) by weight or 22,600 parts per million fluoride ions (ppm F). It contains 2.26% fluoride in the natural carrier resin with alcohol listed as a solvent
- Fluoroprotector contains 0.9% difluorosilan by weight or 1000 ppm F in polyurethane-based varnish (conc. Of F is 0.1% ).

##### **D. Fluoride prophylactic paste**

**E. Restorative materials containing fluoride** (composite resin), glass ionomers , giomers ,resin modified glass ionomers)

##### **F. Fluoride containing devices** (slow release)

#### **Self-Applied Fluorides**

- Fluoride dentifrices
- Fluoride mouth rinses.
- Fluoride gels.



## **Aqueous Solutions and Gels**

Clinical studies comparing gels and solutions indicate that both are the **same order of clinical effectiveness with no obvious superiority of gels over solutions**, however application of aqueous fluoride using two step prophylaxis and topical fluoride is a time consuming procedure.

Gel products have the same formulation of the aqueous solution but with the addition of a gelling agent. A gel is an aqueous suspension of organic or inorganic molecule that are arranged in a weak three dimensional network producing a thickening or gelling of the entire mass, by adding an organic hydroxyl methyl cellulose.

### **Advantages of gel**

- 1-Adhases to surface of teeth for considerable period of time
- 2-Eliminates the need for continuous wetting of enamel surface required by the operator
- 3-Less time consuming because if trays are used ,it is possible to treat 2 or 4 quadrants simultaneously .
- 4-Hazards of accidentally ingesting a large quantity of fluoride is minimized .

## **Foams**

In an attempt to minimize the risk of fluoride overdosage and to maintain the efficacy of topical fluoride treatment , a foam based APF agent has been developed ,the APF foam significantly increased the fluoride concentration in the outer 5mm enamel, similar to that of APF gel .

### **Advantages of Foam based APF agent**

- 1-It is much lighter than conventional gel and therefore only a small amount of the agent is needed for topical application (4gm of gel/mouth while less than 1 gm of foam/mouth)

2-The surfactant in the foaming agent has a cleansing action by lowering the surface tension ,this may also may facilitate the penetration of the material in to the interproximal surface where its action is most needed.

3-Since APF foam does not require suctioning ,it offers advantages for home use as for treatment of young children and disabled persons where saliva evacuation may not be feasible.

### **Methods of application of topical fluorides by dental professional**

**1. Paint on technique**

**2. Tray technique**

**3. Spray** application has been tried in some experiments

### **Sodium Fluoride Solution and gel NaF 2 %**

Concentration is usually 2%, the method of application proposed by researchers was concluded that maximum reduction of caries at 4 application by weekly intervals at age of 3, 7 , 10 , 13 years to coincide with the eruption of the teeth .

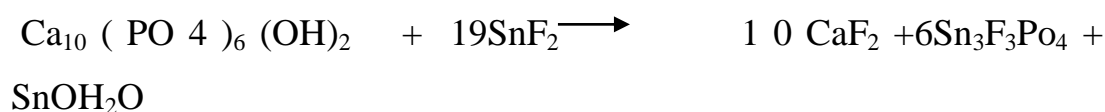
The technique called **Knutson tech.** in which the first visit includes prophylactic scaling and polishing and flossing to clean interproximal areas then NaF is applied in quadrant after isolation and dryness by air syringe ,application of solution by cotton pellet for 4 minutes for every quadrant then instruct the patient not to eat or drink or rinse for at least 30 minutes.

The other 3 visits , only fluoride solution is applied. The reduction in dental caries by NaF range from 20- 40 % in permanent teeth in children in non fluoridated areas, few researchers reported negative results of application when used in adults.

### **Stannous fluoride solution 8 – 10 % SnF<sub>2</sub>**

The method of application similar to sodium fluoride but in polishing we use lavo pumice and application in quadrant ,it comes in form of powder in small containers or in capsules which is then mixed with water when prepared .It can be applied annually or every 6 months the reduction in dental caries reported 38 – 61 %.

In child complaining from rampant caries it can be repeated every 3 months.By application of SnF a complicated agent will be formed.



Sn<sub>3</sub>F<sub>3</sub>Po<sub>4</sub>= Tinflouro phosphate ( complex agent )

SnOH<sub>2</sub>O = hydrated tin oxide

These 2 materials will be incorporated and react with the enamel surface which are the fluoride and tin ions. The tin ion has a benefit of remineralization (not easily disoluted )

### **Advantages of Stannous Fluoride**

- 1-Arrest initial caries (white spot ).
- 2-More effective in reducing dental caries than NaF.
- 3-Used as a desensitizing agent in elderly patient .
- 4-Effective in child and adult .

### **Disadvantages**

- 1-Not stable that undergoes hydrolysis and oxidation to stannous hydroxide and stannous ions so it must be freshly prepared and used .

2-It has a bad taste (metallic )addition of flavoring agents can cause unfavorable reactions.

3-Causes gingival irritation .

4-Causes brown discoloration of teeth and around margins of anterior restoration .

5-Nausea and difficulties in application in children .

### **Acidulated Phosphate Fluoride APF 1.23%**

Many researchers reported that as the PH was lowered fluoride was absorbed in to enamel more effectively .If the PH = 4 ,there will be an increase in the absorption of fluoride. PH lesser then 3 will cause decalcification of the enamel .

There are two types of APF with carboxy methyl cellulose ,and the other is thixotropic (differ in the type of gel material) this is viscous at low shear rate , converted to more fluid state at higher shear rate (less viscous ) so going to flow in between teeth.

Reduction rate of APF was 25 – 67 % in permanent teeth in non-fluoridated areas frequently every 6 months or annually depending on the case.

### **Procedure**

Scaling and polishing and flossing ,apply after isolation and dryness , fluoride gel applied in tray on the teeth after isolation ,instruct the patient not to eat or drink or rinse for half an hour

30 minutes (application for 4 minutes ). It is more recommended and widely used because it has less disadvantages and more effective in reducing dental caries , the preparation has been tested using self application procedure , also can be used in school based programmes .

In a study comparing the reduction rate of fluoride after 2 years application on a daily basis in school and supervised by dental hygienist

75 % reduction with NaF

80 % reduction with APF

### **Disadvantage**

1-Not all the surfaces of the teeth especially the proximal surfaces have been completely covered with fluoride .

2-Practical difficulties like the teeth should be kept wet for 4 minutes, so repeated applications necessitates the use of suction thereby minimizing its use in the field, this also increased chair side time making this fluoride application programme more expensive.

3-It is acidic and sour and bitter in taste.

4-It can not be stored in glass containers because it may remove mineral (etch) the glass.

5-Repeated or prolonged exposure of porcelain or composite restorations to APF can result in loss of materials, surface roughening and possible cosmetic changes .

### **Fluoridated Varnish**

the longer duration and more intimate contact between fluoride ions and enamel leads to a higher fluoride uptake by enamel , fluoride varnish stick to the tooth surface to increase time of retention of fluoride with the tooth surface , it was introduced in 1966 by Henser and Schmidt .A series of varnishes containing fluoride in various form have been formulated.Incorporated in to a soft , flexible polyurethane based adhesive coating .

### **Method of VARNISH application**

1-The teeth should be thoroughly cleaned by rotating brush especially sites most likely to be affected by caries .

2-The required quantity of Duraphate is then squeezed from its tube in to a dappen glass or measuring cup and placed ready for use with a cotton swab .

3-Dry teeth and apply varnish immediately with cotton swab , dipping it repeatedly until the whole surface of tooth is covered evenly .

4-To adhere of varnish to teeth , it must be moist with saliva in order to harden .

After completing the painting it must be kept for 12-24 hours so instruct the patient to take fluid diet and not to brush his teeth during this period to avoid removal of film of varnish and allow maximum penetration of fluoride .After the desired duration of action fluoride varnish is removed by thorough brushing with a tooth brush .

### **Uses of Fluoride Varnish**

- 1- General caries prophylaxis in children and adult .
- 2- Prophylaxis of caries in newly erupted teeth ( initial caries)
- 3- Prophylaxis of secondary marginal caries by painting the preparation border after insertion of filling , inlays, crowns and bridges .
- 4- As desensitizing agent in treatment of hypersensitive necks of teeth .

### **Fluoridated prophylactic paste**

Fluoride has been incorporated in to prophylactic pastes to try to maintain a high concentration in the enamel surface and to determine whether in combination with topical fluoride application an additional caries inhibitory effect can be obtained.

## Fluoride Compounds

1- Inorganic compounds: (e.g. Sodium fluoride (NaF))

readily soluble salts that provide free fluoride; the most commonly used fluoride compound (both selfapplication and professional use); when in solution, NaF salt readily releases fluoride into saliva, dental plaque, pellicle and enamel crystallites.

Used in dentifrices , mouth rinses, chewing- gums, Solutions, gels varnishes ,prophylaxis pastes,slow- release devices

➤ Ammonium fluoride ( $\text{NH}_4\text{F}$ ) although investigated intensively some decades ago, it is currently unused – mainly due to its unpleasant taste and lack of superiority in clinical performance over NaF Formulations used in solutions

➤ Titanium tetrafluoride ( $\text{TiF}_4$ ) able to significantly reduce enamel solubility (as solution),due to the formation of a glaze on enamel and dentine; currently being tested in solutions/varnishes as preventative for caries and erosion used: solutions, varnishes

2 -Monofluorophosphate-containing compounds: fluoride is covalently bound to  $\text{PO}_3^{-2}$  ions and requires hydrolysis to release fluoride ions;

e.g. dentifrices (neutral pH)

gels (neutral and acidic pH)

( $\text{Na}_2\text{FPO}_3$ )one of the main advantages is its compatibility with abrasives.

3- organic fluorides: fluoride bound to organic compounds.

e.g. Amine fluoride which used in dentifrices, gels, mouth rinses , prophylaxis pastes, associated with a reduction in plaque adhesiveness due to the greater affinity of hydrophilic counter- ions to the enamel.

### Goals of Fluoride (F) Administration:

1. Do not harm the patient.
2. Prevent decay on intact dental surfaces.

3. Arrest active decay.
4. Remineralize decalcified tooth surfaces.





### Dental Caries Development

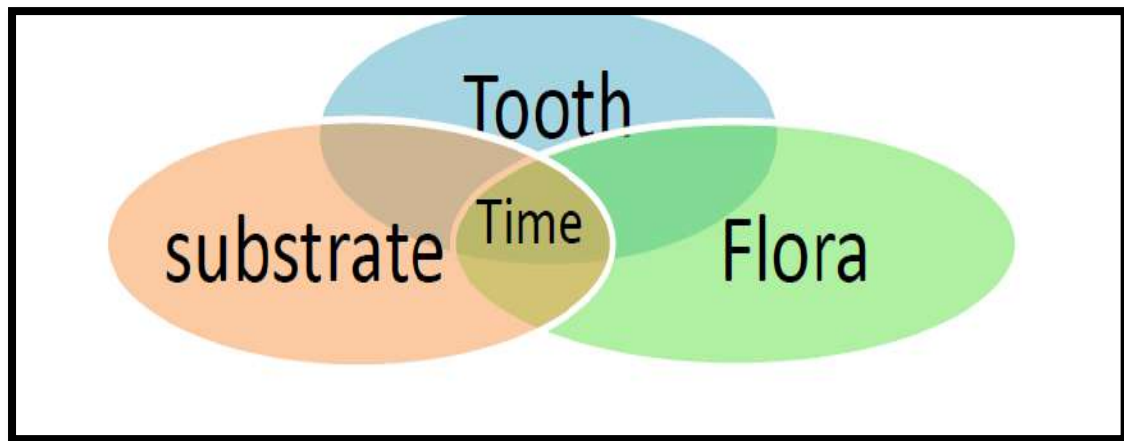
The word ‘caries’ is derived from the (Latin: caries = rottenness).

Dental caries or tooth decay is one of the most common of all disorders. Dental caries has afflicted more humans longer than any other disease. Dental caries affected almost all human populations, at all socioeconomic levels, and at all ages. It is a multifactorial disease characterized by “demineralization of the mineral components and dissolution of the organic matrix”. The destruction can affect enamel, dentin and cementum.

**Carious process** is the result of an interaction of the following:

- 1- Host.
- 2- Plaque.
- 3- Diet.
- 4- Time.

The multifactorial complexity of dental caries can be explained simply by the following figure:



### **Factors Affecting Caries Process:**

**Host Factor:** This involves susceptible **tooth** and **saliva**

**The Tooth:** Factors affecting tooth susceptibility are:

**A-Composition of Teeth :** The inorganic elements contribute to (96% in enamel and 70% in dentin) and the remaining are organic materials and water. Composition of teeth is affected by environmental factors (water, diet and nutrition).

### **Inorganic components composed of major and minor elements**

**Major elements:** calcium, phosphorous, hydroxyl group

$\{Ca_{10}(PO_4)_6(OH)_2\}$  hydroxyapatite crystals.

**Minor elements:** Zinc, copper, strontium, magnesium, fluoride, etc. These elements may incorporate the tooth during tooth formation or incorporate the outer enamel surface later after eruption. Furthermore, these elements may incorporate the enamel crystal in substitutions with one of its major elements. Some of these elements may increase the resistance to caries like fluoride, zinc and others.

While other elements such as magnesium may increase the susceptibility of teeth to caries.

These elements may incorporate the enamel crystal in substitutions with one of its major elements as for example substitution of Ca ions by Mg ( $\text{Ca}_9\text{Mg}(\text{PO}_4)_6(\text{OH})_2$ ) or substitution of the OH by fluoride ions  $\text{Ca}_{10}(\text{PO}_4)_6\text{F}_2$ . These minor or trace elements may also be adsorbed on the surface of the crystals. This incorporation may take place either in the pre eruptive stage including all layers of enamel and dentin, or in the post eruptive stage involving the outer enamel surface only.

The organic constituents and water of both enamel and dentin may act as a diffusion pathway for bacterial acids increasing the tooth destruction. In other way, they permit the penetration of ions for physiological remineralization- demineralization process. Such voids in enamel as well as proteins act as a cushion for intense biting pressure to prevent fracture.

## **B- Tooth Morphology and Arch Form:**

1-Pits and fissure areas of the posterior teeth are highly susceptible to caries

2-Certain surfaces of the tooth are more prone to decay, whereas other surfaces rarely show decay eg. Lower first molars occlusal, buccal, mesial, distal, lingual. Whereas in upper first molar the order is occlusal mesial, palatal, buccal, and distal, also in upper lateral incisor the palatal surface is more susceptible to caries than labial surface.

**C- Position of Teeth:** An intra-oral variation exist in susceptibility to caries between different tooth types Anterior teeth are less affected by dental caries compared to posterior teeth. The most susceptible permanent teeth are the mandibular first molars, followed by the maxillary first molars and the mandibular and maxillary second molars. The second premolars, maxillary incisors and first premolars are the next in sequence. While the mandibular incisors and canines are the least susceptible teeth to develop caries.

**Plaque** An organized mass, consisting mainly of microorganisms, that adheres to teeth, prostheses, and oral surfaces and is found in the gingival crevice and periodontal pockets. Other components include an organic, polysaccharide-protein matrix consisting of bacterial byproducts such as enzymes, food debris, desquamated cells, and inorganic components such as calcium and phosphate.

**Dental plaque** is defined clinically as a structured, resilient, yellow-grayish substance that adheres tenaciously to the intraoral hard surfaces including removable and fixed restorations

**Diet:** It may exert an effect on caries locally in the mouth by reacting with the enamel surface and by serving as a substrate for cariogenic microorganisms. Frequent consumption of sweets between meals lead to continuous drop of pH, thus demineralization will occur.

## **Terminology of Caries**

Dental caries may be classified in a number of ways, according to their anatomical sites.

- ✓ Primary caries is used to differentiate lesions on natural, intact tooth surfaces from those that develop adjacent to a filling material.
- ✓ Recurrent or secondary caries is a lesion developing at a tooth surface adjacent to a filling.
- ✓ Pits and fissures caries is a lesion affected pits and fissure sites of tooth surfaces.
- ✓ Smooth surfaces caries is lesion that may start on smooth enamel as buccal/labial or interproximal surfaces.
- ✓ Arrested caries is a lesion that may have formed years previously and then stopped further progression.
- ✓ Rampant caries is the name given to multiple active carious lesions occurring in the same patient.
- ✓ Nursing bottle caries is one type of rampant caries in the primary dentition of infants and young children, result from sleeping of the child sucking bottle (improper feeding habits).
- ✓ Root caries is lesion on the exposed root cementum and dentin.

### **Dynamics Process of De-/Remineralization**

Dental caries is a disease that is manifested as a dynamic process of de/remineralization in the mouth (Enamel sieve concept).

The first stage of demineralization is occurring at the atomic level far before it can be seen visually as gross demineralization. During this step,

fermentable carbohydrates are metabolized by bacteria in dental plaque to produce organic acids. The acids diffuse into the dental hard tissue through the water among the crystals and could reach a susceptible site on a crystal surface. Calcium and phosphate are dissolved into the surrounding aqueous phase between the crystals. This is considered as the first step in the progress of the dental caries process which can eventually lead to cavitation.

The oral fluids (saliva, biofilm fluid) have calcium (Ca) and phosphate (P) in supersaturated concentrations with respect to the mineral composition of enamel. At physiological conditions (a neutral pH of 7), low ion concentrations are sufficient to keep dental hard tissues in equilibrium. If the pH drops because of acid produced by the dental plaque, higher ion concentrations are needed to prevent dissolution of dental hard tissue. Calcium (Ca) and phosphate (P) ions are continually deposited on the enamel surface or redeposit in enamel areas where they were lost. At a pH of 5.5, under saturation begins, that is, the calcium and phosphate ion concentrations in the plaque fluid are not sufficient to maintain the enamel in stable equilibrium; thus, the enamel starts to dissolve.

Demineralization is a continual imbalance between pathological and protective factors that results in the dissolution of apatite crystals and the net loss of calcium, phosphate, and other ions from the tooth.

The term “remineralization” is used to describe mineral gain. Remineralization is the body’s natural repair process for subsurface non-cavitated carious lesions. In the process of remineralization, calcium and phosphate ions are supplied from a source external to the tooth to

promote ion deposition into crystal voids in demineralized enamel to produce net mineral again.

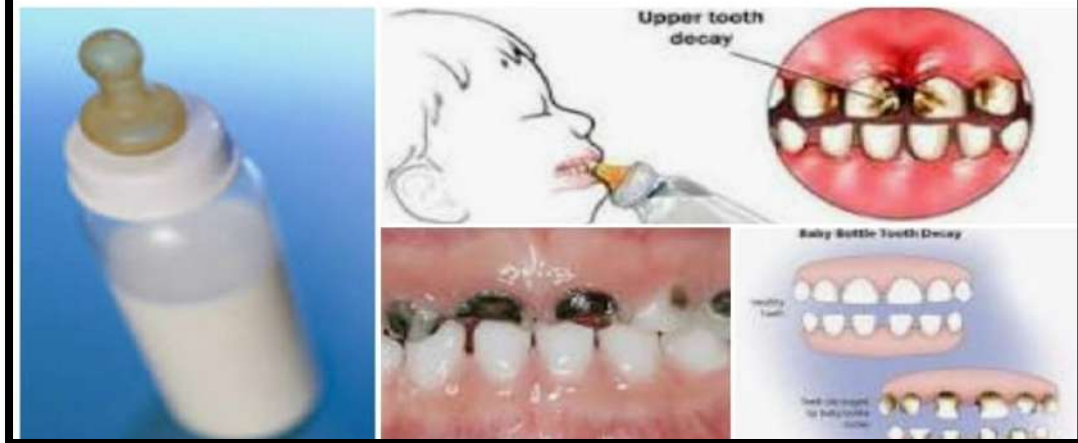
De-/remineralization cycles continue in the mouth as long as there are factors including cariogenic bacteria, fermentable carbohydrates, and saliva.

The balance between pathological factors and protective factors determines whether demineralization or remineralization is proceeding at any one time.

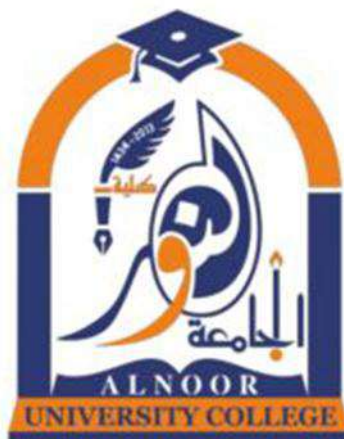
**The development of a carious lesion occurs in three distinct stages:**

- **The earliest stage** is the incipient lesion; macroscopically evidenced on the tooth surface by the appearance of an area of opacity (the white spot lesion), which is accompanied by histologic changes of the enamel at the microscopic level and is well established with a number of recognizable zones.
- **The second stage** includes the progress of the demineralization front toward the dentino-enamel junction and/or into the dentin; the affected dentin displays discoloration from brown to dark brown or black, microscopic changes of dentin showed different zones.
- **The final phase** of caries development is the development of the *overt* or *frank* lesion, which is characterized by actual *cavitation*.

## Baby bottle Syndrome





**Self-applied fluoride agents.**

- a. Fluoride dentifrices.
- b. Fluoride rinses.
- c. Fluoride gels and foams.

**Fluoridated Toothpaste (Fluoridated Dentifrices)**

Fluoride toothpaste is highly cost-effective and a unique public health intervention that combines cleaning of teeth and gums with a caries-preventive effect. There is no other product or intervention with a similar function. For this reason, fluoride toothpaste is considered the most rational way of fluoride use. Fluoridated dentifrices are considered the most cheapest and easiest way of bringing the benefits of fluoride to population. 95 % of all toothpaste on sale contain a fluoride compound. The concentration of fluoride used in dentifrices range from 525 – 1450 with an average of 1000 ppm.

A major problem in manufacturing fluoridated toothpaste is preventing the fluoride from reacting with other ingredients especially the abrasive system ( calcium carbonate and calcium phosphate )

In 1955 researchers applied 0.4% stannous fluoride in a calcium pyrophosphate base under brand name of crest ( it has the disadvantage of brown discoloration of teeth and around margin of anterior restoration )

In 1981 they replaced it with NaF with an abrasive of silicon dioxide marketed as crest + .

Other researchers used sodium monofluorophosphate instead of NaF.

**Sodium monofluorophosphate is superior to other types of fluoride from a compatability point of view with abrasive.**

One problem with young children's use of toothpaste is that they swallow some paste with a subsequent risk of fluorosis .

Fluoride toothpaste may be responsible for up to 80% of the “optimal” total daily intake of fluoride , and the first 3 years of life seems most critical. Therefore, parents must be strongly advised to apply an age-related amount of toothpaste and assist/supervise tooth brushing until at least 7 years of age.

**Children less than 3 years old:** Begin brushing as soon as teeth erupt using no more than **a smear of the size of a rice grain of regular (adult) fluoride toothpaste.** Parents/caregiver brush the teeth 2x/day or as directed by a dentist ,supervision is required to ensure that toothpaste slurry is not swallowed but spat out without subsequent rinsing.

**Children 3 to 6 should use an amount equal to the size of a pea.** This amount is safe even if swallowed.

**High fluoride toothpaste** Toothpastes with more than 1500 ppm F are available on prescription in many countries. Toothpastes containing up to 5000 ppm F, they are primarily intended for patients with special care needs, adolescents with increased caries risk and those under

treatment with fixed orthodontic appliances. Conclusive evidence for their superior effectiveness is, however, lacking.

### **Fluoridated Mouth rinses**

Used in home or school preventive programmes having both systemic and topical effect ,they are used in non fluoridated areas (no systemic water fluoridation ), it comes in different forms ( NaF , APF ) used either on daily or weekly basis .

For daily use 0.05% (225 ppm ) in form of NaF or APF

Weekly use 0.2% (900 ppm ) in form of NaF or APF

For rinsing use 10 ml of the rinse solution for about 1 minute to push the solution between the teeth and swishing it forcefully in mouth then to spit it and not to rinse with water.

### **Fluoride mouth rinse prescribed for :**

- 1) Child with high risk to dental caries.
- 2) Patient with orthodontic appliance , also patient with partial denture or bridge .
- 3) Adult with root caries or sensitive teeth .
- 4) Patient with xerostomia .

### **Not used for :**

- 1) Children under 6 years of age .
- 2) Children given other fluoride supplement

## **Recommendations for fluoride mouth rinses**

1-The rinse and expectorate technique can be used for patients in fluoride –deficient communities or for those in optimally fluoridated communities who exhibit a high risk susceptibility .

2-A teaspoonful of 0.05% NaF solution will ,if swallowed deliver 1mg of NaF. A swish and swallow technique should be recommended if the concentration of fluoride in the drinking water is 0.3 or less or if the patient is not taking other fluoride supplement, it is especially beneficial for patients with increased risk such as patients with orthodontic appliances or undergoing radiotherapy. Over the counter products are not meant to be swallowed .



### **Systemic fluorides include**

1. Community water fluoridation
2. School water fluoridation
3. Fluoridated salt
4. Fluoridated milk and fruit juice
5. Fluoride supplements including fluoridated tablets and drops with/without vitamins

### **Community water fluoridation**

Defined as the upward adjustment of concentration of fluoride ions in the public water supply in such a way that the concentration of fluoride may be constantly maintained at 1 ppm, this is the optimal level of fluoride where the hydroxy apatite crystals during the tooth formation will become fluorapatite when systemic fluoride is taken and enamel surface becomes more resistant to acid attack.

In 1958 the WHO produced first report on fluoridation saying it is beneficial practicable and effective public health measure .Some of the most successful programs of water fluoridation include those in Singapore and Hong Kong which began fluoridation in early 1960 s

### **Artificial Water Fluoridation Level**

The ( 1984 )guidelines for the World Health Organization suggested that the level of artificial water fluoride according to **climate** as:

1. In areas with a warm climate, the optimal fluoride concentration in drinking water should remain below 1 mg/ liter (1 ppm or part per million).
2. While in cooler climates it could go up to 1.2 mg/liter. (A range of 0.7-1.2 ppm). The differentiation derives from the fact that perspiration is more in hot weather and consequently intake is more.

Then the National Advisory Committee on Oral Health suggested a range 0.6-1.1 mg/L with variation within that range according to the mean maximum daily temperature

### **Advantages of Water Fluoridation:**

1. It is effective in reduction of dental caries 50 – 60 % in permanent teeth and 40-50% in the primary teeth.
2. It is safe.
3. Low cost.
4. Its ease of implementation.
5. the benefits of fluoride reaches to the entire population.
6. No motivation or behavioral changes necessary and no effort required other than consuming the water supplies.
7. Having a pre and post eruptive benefit.

### **Disadvantages of Water Fluoridation**

1. Political and/or emotional objections to water additives.
2. Possibility of mild to moderate fluorosis if other sources of fluoride are ingested
3. Alleged toxicity.

### **Systemic Effect of Fluoride:**

**1. Pre-eruptive Systemic Effects:** During tooth development, fluoride is incorporated into the developing tooth's mineralized structure. Although this is no longer believed to be the most important reason for the effect of fluoride in dental caries, the presence of fluoride in the dental enamel probably increases resistance to demineralization when the tooth surface is exposed to organic acids.

### **Systemic Fluoride may enhance the resistance of the tooth by way of:**

1. An alteration in tooth morphology.
2. A conversion of the hydroxyapatite mineral to a fluoridated state with an attendant reduction in solubility and an enhancement of the remineralization phase of the caries process.

### **2. Post-Eruptive Systemic Effects:**

After tooth eruption, fluoride is no longer involved systemically in tooth formation. However, consumed fluoride is excreted through the saliva and can aid in tooth protection throughout the lifetime. At the time of tooth eruption the enamel is not completely calcified and undergoes a post-eruptive period of approximately 2 years during which enamel calcification continues. Throughout this period-period of enamel maturation' there is continuous accumulation of fluoride as well as other elements in the superficial part of enamel.

### **Fluoride compound used in water fluoridation**

1. Fluorspar: It is a mineral containing calcium fluoride [CaF<sub>2</sub>].
2. Sodium fluoride.
3. Silicofluorides.

4. Sodium silicofluorides: Most commonly used due to its low cost. Solutions of this compound are corrosive hence materials for piping, etc. should be chosen accordingly.

5. Hydrofluosilicic acid.

6. Ammonium silicofluoride  $[(\text{NH})_2\text{SiF}_6]$ .

### **School Water Fluoridation**

An alternative to community water fluoridation is the fluoridation of school drinking water. It's most applicable in rural schools, where fluoridation of community water is not feasible. Reduction in dental caries was found to be about 40 percent. , the level of fluoride in school water varies between (2.2 – 5 ppm) ,these levels were chosen because children have only part of their daily water intake at schools, in addition to the reason that they do not attend school all year round ( holiday ) and they enter school at the age of 6 years (central incisors and permanent first molars have erupted or soon to erupt, so that there is no fear from fluorosis)

### **Disadvantages**

- 1) The children do not receive the benefits until they begin school [belated exposure]
- 2) Children consume the fluoridated water only when the school is in session [abbreviated exposure].

To compensate for this belated and abbreviated exposure, the school water is usually fluoridated at 4.5 times the optimum concentration recommended for that place

### **There are two major concerns about school water fluoridation:**

1. By age 6 all teeth except 3rd molars are in an advanced stage of mineralization, thus reducing the pre-eruptive benefits of fluoride.



2. There are no data to indicate expected caries incidence following graduation.

The following table displays the effect of fluoride in water on human health when consumed for longer durations (years)

<b>Fluoride concentration (mg/L)</b>	<b>Effects</b>
<b>&lt;1.0</b>	<b>Safe limit</b>
<b>1.0–3.0</b>	<b>Dental Fluorosis</b>
<b>3.0–4.0</b>	<b>Brittle and stiff bones and joints</b>
<b>4.0–10</b>	<b>Dental fluorosis, skeletal fluorosis (pain in neck bones and back)</b>

### **Fluoridated Salt**

Where water fluoridation could not be initiated, some countries have introduced salt fluoridation. Salt is usually fluoridated at 250 ppm (which is 250 mg F/kg salt, or 0.25 mg/gm salt). Table salt in the kitchen can contribute 1 to 4 g of the daily salt intake. Thus, a person could potentially ingest 1 mg of fluoride a day at a salt intake of 4 grams a day.

#### **Advantages:**

- 1- Wide coverage
- 2- Need little action by the individual
- 3- Low cost
- 4- Freedom for the consumers as both fluoridated and non-fluoridated salt is available
- 5- It is safe
- 6- Minimum possibilities of fluorosis.

**Disadvantages:**

- 1- Salt fluoridation need community education and promotion.
- 2- International efforts to reduce sodium intake to help control hypertension.
- 3- Consumption of fluoridated salt is lowered during early life when the need for fluoride is the maximum.
- 4- Amount of salt intake vary between individuals.

**Fluoridated Milk**

Milk fluoridation is the addition of a measured quantity of fluoride to bottled or packaged milk to be drunk by children .both bovine and human milk contain low level of fluoride about 0.03ppmF. Milk fluoridation is suggested instead of water fluoridation.

Fluoridated milk promotes remineralisation of lesions in enamel *in vitro* and *in vivo*, and inhibits demineralisation in enamel and dentine. Milk itself has a protective effect in intra-oral caries models as well as *in vitro*

**Disadvantages:**

- 1- Consumption of milk varies between different socioeconomic groups .
- 2- Consumption decrease with age so long term benefit is less than water fluoridation
- 3- Require high level of technical expertise.

– A high concentration of fluoride is needed for two reasons:

(1) the children did not drink the beverage throughout the day.

(2) calcium in the milk complexes with fluoride, which would reduce its availability for topical benefits.

### **Fluoride Supplements (Tablets or Drops)**

Fluoride supplements were originally designed to provide the systemic fluoride that a child would not consume living in a non-fluoridated area.

However fluoride supplements should be:

1. Prescribe for children ages 6 months to 16 years who are at high risk for tooth decay and,
2. Whose primary drinking water has a low fluoride concentration.
3. Prescribed only by dentists where there is clear evidence for high risk of caries and non-compliance with using other fluoridated products; and the parents must be cooperative.

Fluoride tablets became the method of choice for fluoride supplementation.

Supplements contain a measured amount of fluoride typically 0.25mg, 0.5mg, and 1mg usually as *sodium fluoride*. 2.2 mg sodiumfluoride tablet gives 1mg ion fluoride, and 1.1 mg sodiumfluoride tablet gives 0.5mg ion fluoride.

Age	Fluoride supplement dosage according to fluoride in the drinking water (parts per million ppm)		
	<0.3ppm	0.3–0.6pp	>0.6ppm
Birth to 6 months	None	none	None
6 months to 3 years	0.25 mg/day	none	None
3 to 6 years	0.5 mg/day	0.25 mg/day	None
6 to 16 years	1.0 mg/day	0.5 mg/day	None

If fluoride level is unknown, drinking water should be tested for fluoride content before supplements are prescribed.

- ✓ Fluoride supplement indicated to children **living in area with none or low level of fluoride in water**. Especially children with high risk to dental caries, children with chronic systemic disease and handicapped children.
- ✓ Fluoride supplement is daily used **from 6months to 16 years** to give their maximum effect (To obtain the benefits from fluoride supplements, long-term compliance on a daily basis is required).
- ✓ To maximize the topical effect of fluoride, tablets and lozenges are intended to be **chewed or sucked for 1–2 minutes** before being swallowed.
- ✓ Before considering supplementing fluoride, it is relevant to take into account the **natural sources of fluoride in food and drinking water**.
- ✓ It has also been shown that when **exposure to fluoride is discontinued, its caries-reducing effect gradually wanes**. This is entirely logical, because fluoride is affecting the dynamics of lesion formation.

- ✓ Fluoride supplement Should not be given with milk.

Fluoride supplement during pregnancy until dental formation is completed through pharmaceutical products, i.e. tablets or drops, according to variable doses (0.25 and 1 mg). During pregnancy and breast feeding, mothers should take 1 mg a day. In fact, theoretically, during intrauterine life, the fluoride taken by the mother may work in the pre-eruptive phase, during the amelogenesis of deciduous teeth with a consequent beneficial effect on the newborn's deciduous teeth. Fluoride passes through the placenta freely, until it reaches excessively high levels in the mother's blood, and thus triggers this passage (barrier effect) to protect the foetus from excessive doses. The threshold concentration that pushes the placenta to trigger this function is 0.4 ppm of fluoride in maternal blood . Some Authors consider the systemic administration of fluoride as a further supplement during pregnancy, as it is identified as the first step to caries prevention.

The children until they are old enough to swallow use Fluoride supplement as Fluoride Drops; they are available as 0.125mg, 0.25mg, 0.50mg drops . 10 drops equal to 1mg, if 10 drops placed in a liter of water the result concentration of 1ppm of fluoride.



## Prevention

lect 4 Dr. Raya Jasim

### Fluorides In Dentistry

Fluorine is an element of the halogen family, including chlorine, bromine and iodine. Due to its reactivity, fluorine exists almost as a fluoride. Fluoride (F) constitutes about 0.032% of the earth's crust.

Fluoride is the simplest fluorine anion. In terms of charge and size, the fluoride ion resembles the hydroxide ion. Fluoride ions occur on Earth in several minerals, particularly fluorite, but are present only in trace quantities in bodies of water in nature.

Fluoride has been found to be a very important element in the prevention of dental caries, this has been proved by epidemiological experimental and clinical studies.

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.

## **Historical background**

In 1901 Dr. Frederick McKay arrived in Colorado springs, he noticed that many of his patients, especially those who lived in the area had a permanent stain on their teeth called by the residents Colorado Stain .

In 1912 McKay discovered that people from parts of Naples in Italy had a dental peculiarity known locally as denti di chiaie this mottling of the teeth was the same feature as that found in Colorado springs.

In 1931 Churchill who was a chemist found that the cause of the mottled enamel was due to high levels of fluoride in the water supplies that was analyzed.

In 1933 Dean studied the relationship between the severity of mottled enamel and fluoride concentration in water supplies. Ainsworth also in 1933 reported that caries experience in high fluoride areas was markedly lower than caries in other districts with low fluoride content .

Dean with his researchers found that maximum reduction in caries occurred when concentration of fluoride was 1ppm , at this conc. Fluoride causes sporadic instances of the mildest forms of dental fluorosis of no practical esthetic significance .

Artificial water fluoridation was started in 1945 , the experiment was carried out by Dr. Dean in Grand Rapids which was the experimental town and Muskegon was the control town ( DMFT was the same in both cities in 4 -16 year olds ) .Sodium fluoride was added to the water supply of Grand Rapids ,after 6 ½ years DMFT rates where measured , the children of Grand Rapids had almost half the DMFT of Muskegon , other cities began to start water fluoridation .

## **Fluoride in Environment ( Sources of fluoride intake ):**

Fluorine is never seen in nature in the elemental form because it is the most electro negative of all chemical elements. It 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  $\text{CaF}_2$ ). 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 ( $\text{Ca}_{10}[\text{PO}_4]_6\text{F}_2$ ).

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 fluor spar 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/lit. 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.

### **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)**

Ionic form is of significance in dentistry and public health and is detected by ion-specific electrode.

The second is the **the non ionic or bound fluoride**. 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 Tissues**

The intracellular fluoride 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.

Cancellous bone has higher fluoride concentrations than compact bone. Dentin 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.

### **Factors affecting absorption of fluoride from the GIT .**

1-Presence of food in the stomach may affect the absorption of fluoride because this food act as a physical barrier for absorption of fluoride ions from the GIT.

2-Presence of other elements in the stomach that fluoride may bind to like calcium , magnesium , phosphate , aluminum leading to decrease in the ionic form of fluoride leading to decrease absorption of fluoride ions ( that is why in case of fluoride toxicity the patient is given milk because calcium in milk will bind to fluoride leading to decrease fluoride absorption .

3-Types, solubility of the fluoridated dental product ex NaF absorption from the GIT is faster than sodium monoflourophosphate , so absorption of NaF is faster.

4-Acidity of the stomach which is an important factor that increase fluoride absorption because of presence of acidity which lead to increase dissociation of ionic fluoride, increasing the rate of absorption of fluoride from the GIT.

### **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 Faeces**

It is generally accepted that most of the fluoride in the faeces 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.

## **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

## **Types of Fluorides**

Fluoride has 2 types of effects systemic and topical depending on the delivery method used, systemic fluoride provides a low concentration of fluoride to teeth over a long period, it circulates in the blood stream and is incorporated in the developing teeth, and after teeth erupt fluoride contacts teeth directly through salivary secretions.

Topical fluorides are placed directly on the teeth ,some preparations provide a high concentration of fluoride over a short time, topical fluoride allows interaction of fluoride with minerals in the teeth.

Some fluoride preparations provide both topical and systemic effects ex fluoride mouth rinse used swished to obtain topical effect and swallowed. Most systemic fluorides have a topical effect but their primary effect is systemic.

Community water fluoridation

School water fluoridation

Dietary fluoride supplements



### **Traditional *versus* Novel Methods in Caries Diagnosis**

Early detection and diagnosis of dental caries reduces irreversible loss of tooth structure, the treatment costs and the time needed for restoration of the teeth.

A diagnostic method for dental caries should allow the detection of the disease in its earliest stages and for all pathologic changes attributable to the disease to be determined from early demineralization to cavitation's. Unfortunately, none of the currently accepted clinical caries diagnostic methodologies have the ability to account for the dynamics of dental caries, including the possibility of reversal.

### **Criteria for an ideal caries detection method include following**

- 1) Ideal caries detection method should capture the whole caries progress, from the earliest stage to the cavitation stage,
- 2) It should be accurate.
- 3) It should be precise.
- 4) It should be easy to apply.
- 5) It should be useful for all surfaces of the tooth including caries adjacent to restorations.
- 6) It should assess the activity of the lesion.

- 7) It should be sensitive, allowing lesions to be detected at early stages.

## **Conventional Methods Used in Diagnosis of Dental Caries**

### **Visual Inspection**

It is one of the most common diagnosis methods implemented by dentists. In order to make an accurate assessment, the teeth should be clean, dry and examined under a light source. In visual examination, changes in tooth structure such as; enamel dissolution, white spot lesions, discoloration, surface roughness and presence of cavitation are assessed. When illuminated, the carious tissues scatter the light and make enamel look whiter and opaque. This is due to increased porosity caused by demineralization. Detection of initial caries by sharp probe may lead to cavity formation which reducing the chance of remineralization of intact surfaces. Tactile examination using explorers allows for detection of roughness, soft floors, frank cavitation, white spot.

### **Tactile Sensation**

The explorer and the dental floss are used for tactile examination but the use of an explorer is not preferred because

- 1) Sharp tip of the explorer can produce traumatic defects on the enamel surface,
- 2) The cariogenic bacteria may be transferred from one tooth surface to another.

- 3) Explorers have low sensitivity resulting in undetected lesions.

For diagnosis of caries you should use **Sharp eyes and a blunt probe**

### **Benefits of visual and tactile examinations**

- ✓ Is quick and easy to perform.
- ✓ Does not need expensive equipment.

### **Radiography**

Radiographic examination has great value in detecting caries lesions especially when they are not clinically visible. In low caries population, as a result of fluoride use, the surface of enamel does not break down, making the caries detection harder. In recent years, the incidence of such lesions has increased dramatically. According to studies, bitewing radiography has been proven to be an effective method in the detection of proximal caries and hidden caries.

Besides its advantages, radiographs also have some limitations too. For this reason, it is advisable to use clinical evaluation along with radiographic imaging.

### **The disadvantages of radiography are as follows:**

- 1) Proximal contacts are overlapped. miss diagnosis can occur superimposition, angulation of cone, difficulty of film position.
- 2) The lesion depth may appear to be increased due to angulation and this may lead to false diagnosis.
- 3) Occlusal lesions may not be detected because of the superposition of the buccal and lingual cusps.



- 4) The real cause of the radiolucency can't be determined whether it is due to caries, resorption or wear.
- 5) The superficial demineralization of the buccal and lingual surfaces may seem like proximal caries.
- 6) Active and arrested caries can't be distinguished in the radiographs.

The intervals between bitewing examinations should be based on individual risk assessment. Annual examinations should be considered in the following situations:

- Age 5–7: one or more approximal dentin lesion or several approximal enamel lesions in primary molars
- Age 7–12 (mixed dentition): a permanent first molar with approximal caries, half through the enamel or several approximal lesions in primary molars
- Age 12–13: – one or more approximal dentin lesion or restored approximal surface – three or more approximal enamel lesions – any unrestored approximal dentin lesion – a recently restored approximal neighboring surface

## **Caries Detecting Dyes**

In 1972, it was suggested that caries detector dyes could help differentiate infected dentin from affected dentin. However, more recent studies have shown that these dyes are non specific protein dyes that stain collagen in the organic matrix of less mineralized dentin, whether it is infected or not, rather than being specific for the pathogenic bacteria.

There are two layers of decalcification in carious dentin. The first one is the soft and infected layer which doesn't have the capacity of

remineralization. The second one is hard, intermediately decalcified and has the ability of remineralization. Many studies were carried out to differentiate these layers. Most clinical investigations have concluded that, caries detection dyes don't stain bacteria but stain the less mineralized organic matrix.

## **Novel Methods for Caries Detection**

### **Digital Imaging**

Digital image is an image composed of a series of sensors and pixels distributed orderly

**The advantages of digital imaging over conventional radiography is as follows :**

- 1) The radiation dose is approximately 60-90% lower.
- 2) The image receptor is often larger.
- 3) The image is immediately available.
- 4) The image can be electronically transferred.
- 5) Magnification, contrast, brightness can be adjusted,
- 6) There is no need for processing solutions so, protecting the environment and lowering the costs

In order to be seen in the radiographs, there must be 40% of demineralization in the lesions.

### **Fiber Optic and Digital Fiber Optic Transillumination Imaging**

The light transmission index of decayed and sound tooth are different. Sound enamel is formed of densely packed hydroxyapatite crystals. When this structure is disrupted, in the presence of demineralization, the photons of light are scattered resulting in an optical disruption. When we examine the carious tissues with fiber optic device, we observe dark

shadows along the dentinal tubules as it has lower light transmission index compared with the sound tooth structure .The best utilization of the fiber optic transillumination (FOTI) device is for evaluating the depth of occlusal lesions (if the caries has reached to the dentin or not) and for the detection of the proximal lesions.

Fiber-optic transillumination (FOTI) is a diagnostic method by which visible light is transmitted through the tooth from an intense light source, for example from a fine probe with an exit diameter of 0.3–0.5 mm. If the transmitted light reveals a shadow when the tooth is observed from the occlusal surface this may be associated with the presence of a carious lesion. The narrow beam of light is of crucial importance when the technique is used in the premolar and molar region. For optimal performance the probe should be brought in from the buccal or lingual aspect at an angle of about 45 degrees to the approximal surfaces pointing apically, while looking for dark shadows in the enamel or dentin

**DIFOT** is a method which is the combination of the FOTI and a digital camera in order to reduce the shortcomings of FOTI. This system uses 780 nm wavelength near infrared radiation instead of white light source .

Digital Imaging Fiber Optic Transillumination (DIFOTI) is used for detection of both incipient and frank caries in all tooth surfaces, fractures, cracks and secondary caries around restoration. This is a digitized and computed version of the FOTI.

DIFOTI uses white light to transilluminate each tooth and to instantly create high-resolution digital images of the tooth. It is based on the principle that carious tooth tissue scatters and absorbs more light than surrounding healthy tissue. Decay near the imaged surface appears as a

darker area against the more translucent brighter background of surrounding healthy anatomy.

This new detection method looks promising for identification of caries and measuring the severity of the lesions. According to studies, this method is non-invasive, doesn't use ionizing radiation and it is more sensitive than X-rays in detecting early demineralizations.

## **Fluorescence**

Two methods have been developed based on the fluorescence of the organic components of teeth; they are quantitative light-induced fluorescence [QLF (QLF-clin, Inspector Research Systems BV, Amsterdam, Netherlands)] which uses an arc lamp with a wavelength of 290-450 nm and DIAGNOdent (KaVo Dental laser fluorescence pen, DIAGNOdent pen, Lake Zurich) which uses Infrared light and has a 655 nm wavelength .

## **Quantitative Light Induced Fluorescence (QLF)**

This technique is based on the principle that as the mineral content of the tooth changes the auto fluorescence of the tooth changes also. The light scatters much faster in carious tissues compared to sound dental tissues, shortening the pathway of the light in the lesion and decreasing the absorption and fluorescence in this area. This means that, the scattering of the light is used for evaluating the mineral loss related with the lesion. The QLF method can also be used in measuring the red fluorescence from microorganisms in plaque. The value of red fluorescence can be used in the evaluation of oral hygiene, assessment of the plaque on the dentures, detection of the infected dentin and detecting the leakage of a sealant or caries at the margin of a restoration

QLF has inability to detect or monitor interproximal lesions and is limited to measurement of enamel lesions several hundred micrometers depth.

### **Laser fluorescence - DIAGNODent**

It is another device employing fluorescence to detect the presence of caries. Using a small laser, the system produces an excitation wavelength of 655 nm, which produces a red light. This is carried to one of two intra-oral tips: one designed for pits and fissures, and the other for smooth surfaces. The tips both emit the excitation light and collect the resultant fluorescence.

The device doesn't produce an image of the tooth, it displays a numerical value. The device is aimed in detection of occlusal and smooth surface lesions. Clinically visible white spot lesions are measurable with this device. However, very initial lesions, with no fluorophores from bacteria present, are not captured by the DIAGNODent. The same registration under dry conditions led to higher cut-off point. The intensity of the fluorescent light is displayed as a number ranging from 0 to 99, with 0 indicating a minimum and 99 a maximum of fluorescent light.

A new version of the method was designed named DIAGNODent pen permits assessment of both occlusal and proximal surfaces. The device works on the principles of the old version but the design is different. After excitation, the tip collects the fluorescence and translates it into a numerical scale from 0-99.

**Diagno-Dent** It is an effective method in detecting initial lesions without cavitation. It's also useful for measuring different decalcification values in different surfaces of the tooth. The fiber optic probe directed onto the occlusal surface of the tooth emits a light of wavelength 655 nm

The changes caused by demineralization are converted into numeric values and displayed on the screen. The surface to be examined must be clean because dental calculus, plaque and discoloration may cause false results .

According to studies carried on permanent teeth it is indicated that DIAGNOdent has high sensitivity and low specificity. Having a high sensitivity means that the tool is suitable for caries detection but having low specificity means a higher rate of false positive results are obtained. Therefore, it is recommended to use DIAGNOdent in combination with other techniques.

### **Electrical Conductivity Measurements**

Because of its high mineral content, sound enamel is a good electrical insulator. Demineralization process results in the formation of pores and saliva fills these pores forming a conductive pathway for electric current . The electrical conductance increases as the pores get larger meaning that demineralization is directly proportional with electrical conductance will be detected and the dental structures will be protected by implementing preventive treatments.

### **Other methods of diagnosing dental caries include:**

Ultrasonics (Ultrasound Caries Detector),Cone Beam Computed Tomography. Infrared Thermography.

**Conclusion:** The caries detection tools aim the early detection of caries and prevent the progression of caries from demineralization to cavitation. None of the mentioned techniques **alone** are sufficient for diagnosis of dental caries. In the future, with the development of the diagnostic tools,

small changes in the tooth structure will be detected and the dental structures will be protected by implementing preventive treatments.