

## **Dental caries development**

The term dental caries (tooth decay) is used to describe the results – the signs and symptoms – of a localized chemical dissolution of the tooth surface caused by metabolic events taking place in the biofilm (dental plaque) covering the affected area. 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. Dental caries affecting a large number of population.

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

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

**Host Factor:** This involves susceptible tooth and saliva. Several factors affecting tooth susceptibility are:

**1- Morphology of teeth:** Dental caries lesions may develop at any tooth site in the oral cavity where a biofilm develops and remains for a period of time. Such sites include pits, grooves and fissures in occlusal surfaces, especially during eruption, approximal surfaces cervical to the contact point/area and along the gingival margin. Insertion of foreign bodies to the dentition (e.g. fillings with inappropriate margins, dentures, orthodontic bands) may also result in such ‘protected’ sites.

These areas are relatively protected from mechanical influence from the tongue, the cheeks, abrasive foods and, not least, tooth brushing. These are the sites where lesion development is more likely to occur because the biofilm is allowed to stagnate there for prolonged time.

**2- Position of teeth:** 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. Whereas the mandibular incisors and canines are the least to develop caries.

**3- Composition of teeth:** The tooth is composed mainly of inorganic elements (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 involve:**

- **Major elements:** calcium, phosphorous, hydroxyl group  $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ .
- **Minor elements:** Zinc, copper, strontium, magnesium, fluoride, etc. These elements may incorporate the enamel crystal in substitutions with one of its major elements as substitution of hydroxyl group by fluoride ion and formation of  $\text{Ca}_{10}(\text{PO}_4)_6\text{F}_2$ . Certain elements (fluoride, zinc, iron, chloride) accumulate in the enamel surface, while others are sparse in surface as compared with subsurface enamel. Changes of the enamel (decrease in density and permeability, an increase in fluoride content) occur with age.

Some of these elements are incorporated into the enamel and 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.

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 caution for intense biting pressure to prevent fracture.

**Saliva** through its secretion and composition affects dental caries development. It can affect the number of microorganisms through cleansing action (oral clearance), While buffer system in saliva affects the integrity of teeth as well as calcium and phosphate.

**Dental plaque:** The cariogenic bacteria in plaque consist of *mutans streptococci*, *lactobacilli* and other types. Bacteria ferment carbohydrate causing release of acid lead to demineralization of tooth surface.

**Diet:** Frequent consumption of sweets between meals lead to continuous drop of pH, thus demineralization will occur.

### **Terminology of caries**

- Primary caries is lesion on natural, intact tooth surfaces
- Pits and fissures caries is a lesion affected tooth occlusally.
- Smooth surfaces caries is lesion that may start on enamel.
- Recurrent or secondary caries is a lesion developing at a tooth surface adjacent to a filling.
- 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 a sleep sucking bottle.
- 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). 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 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 continuum 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 are 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.

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 gain.

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

## **Root caries**

Root caries differs from coronal caries (enamel and dentin) in several aspects (mineralization and bacterial invasion).

***Clinical appearance:*** Root-surface caries comprises a continuum of clinical manifestations ranging from small, slightly softened and discolored areas to extensive, yellow–brown soft or hard areas, which may eventually encircle the entire root surface. The lesions may or may not be cavitated. However, even in the case of rather extensive lesions, cavitation does not necessarily involve the pulp. Root-surface caries lesions may be classified as:

- An active root-surface lesion is a well-defined, softened area on the root surface that shows a yellowish or light- brown discoloration. The lesion is likely to be covered by visible plaque. Some slowly progressing lesions may be brownish or black and reveal a leathery consistency on probing with moderate pressure.
- An arrested (inactive) root-surface lesion appears shiny and is relatively smooth and hard on probing with moderate pressure. The color may vary from yellowish to brownish or black. In both active and inactive lesions, cavity formation may be observed, but in the latter, case the margins appear smooth.