Preventive Dentistry
5th Year- Dental Students
Al- Isra'a University
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Lec. 14: Diet and Dental Caries (1):

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Diet refers to the food and drinks that passes through the mouth, whereas ***nutrition*** is concerned with the absorption and metabolism of nutrients from dietary sources.

Diet has a **local effect** on oral health, primarily on:

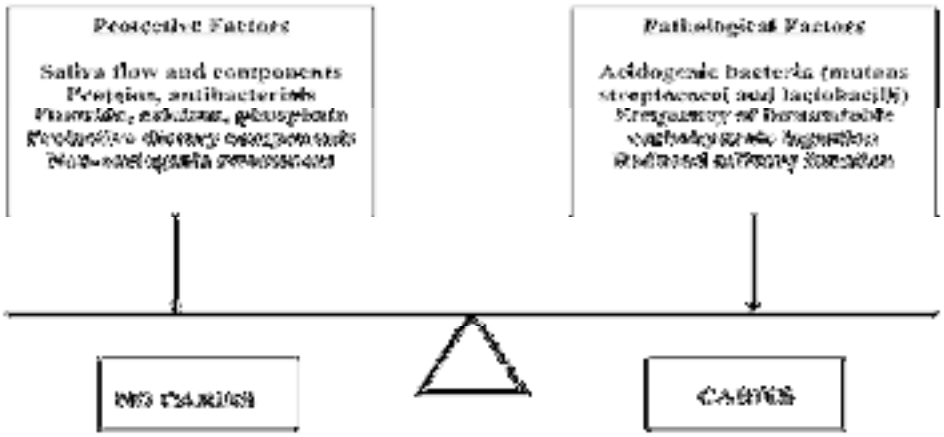
- The integrity of the teeth
- pH and composition of saliva and plaque

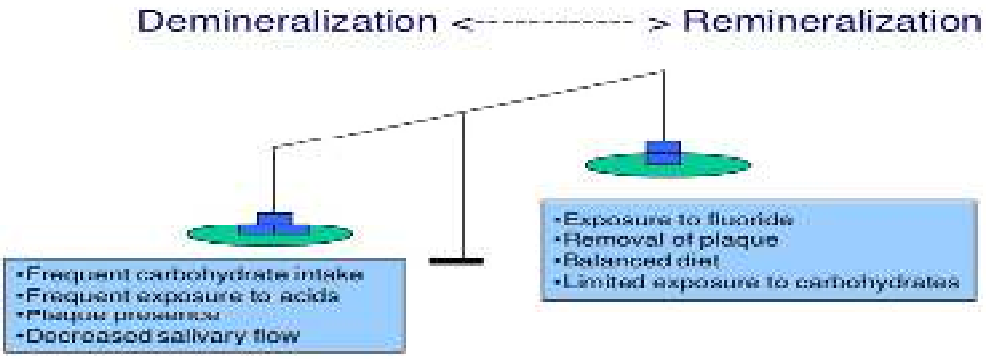
Nutrition has a **systemic effect** on the integrity of the oral cavity. Nutrition is an integral component of oral health, any alterations in the nutrient intake can affect:

- The integrity of the teeth
- Integrity of periodontium
- Integrity of alveolar bone
- Others effects as wound healing

Relation between diet and dental caries:

Food may affect dental caries through their physical properties, constituents and acidity. It may interfere with the balance of tooth de-mineralization and re-mineralization. ***Dietary sugars*** and other ***fermentable carbohydrates***, are metabolized to acids by plaque bacteria. This acid may diffuse through the plaque to the outer enamel surface causing dissolution of minerals, if this continue it may lead to continuous de-mineralization thus dental caries. Acid produced by fermentation of carbohydrate cause also a drop in pH, that favors the growth of the acidogenic and aciduric bacteria (as *mutans streptococci*). In contrast, a diet lower sugars and fermentable carbohydrates and rich in calcium and other minerals as phosphate and fluoride may favor re-mineralization.





Fermentable Carbohydrate and Dental Caries:

Fermentable carbohydrate: any carbohydrate that can be hydrolyzed by salivary amylase in the initial stage of carbohydrate digestion and subsequently fermented by bacteria.

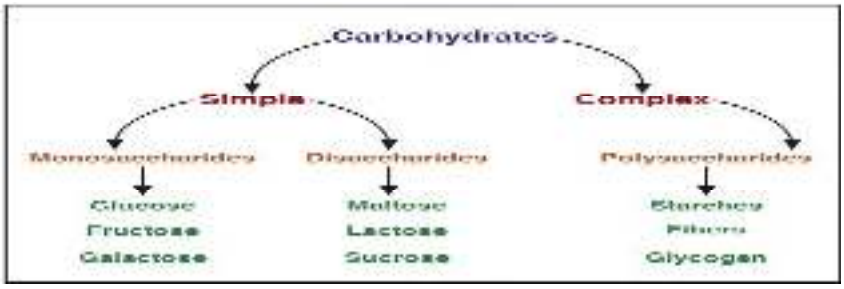
Carbohydrates can be divided into three groups:

1- **Monosaccharide (simple sugars):** The word monosaccharide is derived from mono (; one), and saccharide (; sugar). The common monosaccharide's are glucose, fructose, and galactose. Found in sugar, honey, fruit, fruit juice.

2- **Disaccharides (two sugars),** are commonly found in nature as sucrose (refined from sugar cane), lactose (milk sugar) and maltose.

3- **Polysaccharides or complex carbohydrates** are usually monomers and consist of thousands of repeating glucose units. Starch is the

digestible form of polysaccharides found vegetables, grains like oats, barley and rice.



The four carbohydrates **starch, sucrose, fructose and glucose** comprise the greatest proportion of foods consumed by man.

Studies have confirmed the *direct relation* between intake of *dietary sugars* and *dental caries* across the life span.

Types of Evidence Studies regarding Carbohydrate and Dental Caries:

1- Epidemiological and observational studies: concluded that carie. prevalence and incidence is low among people consuming food with low sucrose. On the other hand an *increase* in dental caries were reported with increase sugar intake.

During World ***Wars I and II***, there was a significant drop in dental caries in numerous countries, as a result of a reduction in the availability of sugar, as the government imposed sugar rationing. Incidence of dental caries among ***native population*** (as Eskimos), was reported to be low, but increased dramatically after exposure to modern type of food.

Another proof regarding sugar intake and dental caries, is the low caries severity among children affected by ***hereditary fructose intolerance*** (; disorder in sucrose metabolism), as sugar intake is avoided among them.

2- Experimental Studies: Different human, animals and laboratory experimental studies were conducted relating dietary sugar and dental caries concluded a presence of a direct relation between the two.

a- ***Animal studies***: showed that animals fed a diet rich with carbohydrates develop caries in more rate and severity compared to the control (animals fed non cariogenic diet).

b- ***Interventional human studies***: dental caries were reported to increase among group of people given food rich in fermentable

carbohydrate in comparison to a control group. Three famous experimental studies are reported these are:

The **Hopewood House study**; dental status was studied among children residing at Hopewood House, Australia, a house for orphan children. Almost all had lived from infancy till age 12- year at this place on a nutritionally adequate lacto-vegetarian diet with absence of meat, and rigid restriction of refined carbohydrates. Dental caries prevalence in young children in Hopewood House was almost negligible in primary dentition. It was markedly less than Australian child's permanent teeth even though oral hygiene in these children was extremely poor. However, an increase in severity of dental caries recorded when those left the house and exposed to ordinary diet rich in carbohydrates.

The Vipeholm Study; was a 5-year investigation of 436 adult inmates in a mental institution at the Vipeholm Hospital, Sweden in (1954). The institutional diet was nutritious, contained little sugar and no between-meal snacks. Dental caries rate was relatively low among them. The experimental design divided the inmates into seven groups; sugar was introduced either at mealtime (in bread and solution) or between meals (in caramels, toffee, and chocolates). The main conclusions of the study were as follows:

- the frequency of intake was much more significant than the amount of carbohydrate ingested.
- The risk of caries was greater if the sugar was consumed in a form that retained on the surfaces of teeth.
- Caries activity was greatest if the sugar was consumed between meals in a form that tended to be retained on the surfaces of the teeth.
- The increase in caries activity varied widely between individuals.
- Upon withdrawal of the sugar-rich foods, the increased caries activity rapidly disappeared.
- The clearance time of the sugar correlated closely with caries activity.

The Vipeholm study showed that the physical form of carbohydrates (stickiness, oral clearance time, frequency of intake) was much more important in cariogenicity than was the total amount of sugar ingested.

The Turku sugar study; In a 2-year dietary study, 125 young adults were divided into three experimental groups: sucrose, fructose, and xylitol. The purpose was to study differences in the caries increment rate as influenced

by various sugars. Results showed a massive reduction caries in relation to xylitol consumption. Fructose was found to be less cariogenic than sucrose. It was suggested that anti-cariogenic properties of xylitol depend on its lack of suitability for microbial metabolism and physico-chemical effects in plaque and saliva.

3-Other studies; like ***enamel slab*** experiments, as enamel slabs are prepared from human teeth and inserted in the mouth of volunteered with removable appliances, to study the demineralization of enamel introduced by different food. Another type of studies, to test the rate of enamel dissolution, named ***incubation studies*** conducted in ***laboratories***, by mixing cariogenic food, saliva with enamel.

4-Plaque pH studies; aimed in measuring the acidogensity of diet through monitoring the changes in plaque pH by different dietary items.

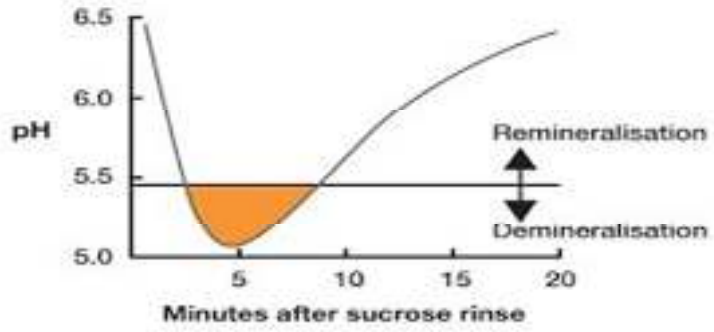
Cariogenicity of Food:

Cariogenicity is ability of producing or promoting the development of carious lesions. The ***cariogenic potential*** of food is to foster caries in humans under conditions conducive to caries formation. The cariogenic potential of foods and beverages is based primarily on the ability of food to decrease plaque pH by acid produce by cariogenic bacteria. This property of food is termed ***acidogenesis***.

Stephan Curve:

The pH of dental plaque under resting conditions (; when no food or drink has been consumed), is between (6.5 – 7). Differences do exist, however, between individuals and in different sites within an individual.

After exposure of dental plaque to a fermentable carbohydrate the pH decreases rapidly, reaching a minimum in approximately five to 20 minutes. This is followed by a gradual recovery to its starting value, usually over 30 to 60 minutes. The plot of plaque pH against time is known as Stephan curve.



If the **pH** value drops below **5.5**, enamel de-mineralization started. This pH is known as the critical pH.

Critical pH; is the pH at which saliva and plaque fluid cease to be saturated with calcium and phosphate, thereby permitting the hydroxyapatite in enamel to dissolve. Then over time, with the mechanical action of saliva plus buffering, the pH returns to resting pH, and re – mineralization phase is started. The increase in the time of low pH, means continuous de-mineralization of enamel thus dental caries.

Hypo salivation cause long and deep Stephan curve, lengthening the time of demineralization and reducing the time for re mineralization. Consumption of sugar with meals is less cariogenic than taken between meals as the effect on pH is minimized due to the dilution effect and increased salivary flow rate due to mastication of other food.

Factors affecting food cariogenicity:

Although **acidogenesis** is an important variable in relation to cariogenicity of food many other factors do exist including:

- **Types of carbohydrate**: Sucrose is considered to be the "arch-criminal" of dental caries as it is more cariogenic than other sugars. It is broken down into its simple sugars glucose and fructose by extracellular bacterial inverters in the oral cavity. The simple sugars serve two purposes – to act as **substrates** for plaque microorganisms and to support the **synthesis of extracellular** (water-soluble and water-insoluble) glucans by ***mutans streptococci***, enhancing its accumulation in the plaque. Lactose (milk sugar) has been shown to be *less acidogenic* than other sugars thus less cariogenic. Xylitol is described as (non -cariogenic) because it is non acidogenic. Insoluble starch (raw starch) is not acidogenic, while soluble starch and cooked starch are break down by

salivary amylase to maltose, glucose and maltotriose, and became acidogenic.

- **Physical form of carbohydrates**: The consistency, solubility and adhesiveness of carbohydrate all affects the clearance time of fermentable carbohydrate from oral cavity. The clearance time vary according to type carbohydrate, solutions with sugar usually cleared in 4 – 5 minutes as sticky type of sugar may need longer time from 30 – 40 minutes. Increase retention of sugar in the oral cavity may increase the their cariogenicity.

Clearance time of different carbohydrate:

- Soft drinks and juice in 5- minutes
- Chewing gums, toffees and lozenges in 40 minutes
- Chewing gums (with sugar substitutes) in 15 – 20 minutes

To increase the time of **sugar clearance** from oral cavity it is advised to:

1- Bruch teeth immediately after meal.
2- Stimulate salivary secretion by mechanical or gustatory stimuli as sugar free chewing gum, eating tough food.
3- Mouth rinsing with water

- **Frequency of carbohydrate intake**: The cariogenicity of sugar increases with its frequent intake, it leads to drop of the pH of plaque and not given enough time for salivary buffer to neutralize the acidity. It has been reported that taken sweet within meal may decrease cariogenicity due to increase salivary flow rate attributed to mechanical stimulation of saliva by food.

Appendix

General comments concerning diet and dental caries:

Diet: a term derived from diatia; way of life

Nutrition: a process by which living organisms physiologically absorbed and metabolize food to ensure growth, energy production, repair of tissue and ultimately reproduction of the species (nutrition to nourish).

Galactose: occur only as a result of the break down and digestion of lactose.

Sucrose: a major part of dietary sugar formed when one molecule of glucose combined with one molecule of fructose.

Lactose: formed when a molecule of glucose combine with a molecule of galactose (milk sugar).

Maltose: is formed when two molecules of glucose combine, and it is mainly derived from hydrolysis of the starch.

Dental caries; occur beneath dental plaque and this distinguish for dental erosion that is dissolution of enamel because of acid from non- cariogenic bacteria.

Main conclusions of Vipholm study:

1- Sugar intake even when consumed in large amount had little effect on caries increment if it was ingested up to a maximum of four times a day at meal times only.

2- Consumption of sugar in between meals was associated with a marked increase in dental caries.

3- The increase in caries activity disappear on with-drawl of sugar- rich food.

4- Dental caries experience showed a wide individual variations.

The rapidity with which the pH falls is a reflection on which sucrose come diffused in to plaque and the activity of concentration of enzymes produced by a great number of bacteria in plaque.

The rate of recovery to the resting pH, critical factor in caries depends on;

1- Rapid production of high concentrations of acid within plaque, temporarily overcomes local buffering factors.

2- Escape of acids into saliva, delayed by diffusion limiting properties of plaque and its thickness.

3- Diffusion of salivary buffer in to plaque hampered by the diffusion – limiting properties of plaque and its thickness.

4- Continued sugar production from bacterial intracellular poly saccharide.

Sugar in free form is harmful to teeth, while there is no evidence by epidemiological studies that sugar in cellular structure of a food is harmful to teeth.

Cariogenisity of plaque depends on its ability to:

- Adhere to teeth
- Resist dissolution by saliva
- Its protection of bacterial acids from salivary buffers.

In absence of sucrose S. mutans cannot colonize on teeth

Starch and plaque pH: the pH drop is very little following consumption of raw starch but soluble starch and starch containing food as bread cause a pH fall but smaller than sucrose. Heating at temperature used in cooking cause a partial degradation to a soluble form, which can be broken by amylase in oral cavity to maltose, glucose and maltotriose.

Mixture of starch and sucrose cause more caries than starch alone probably due to prolong retention.