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Nutrition in dental caries prevention

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According to present opinions the dental caries is caused by a complex interactions among three basic factors : receptive tooth tissue, oral microflora, diet. Time period is seen as the factor number four, because the caries process needs time to develop.

Oral microflora and plaque are present on the dental surface. Microorganisms of the plaque produce acids, on the first place by the fermentation of saccharides from the diet. Subsequently, the acids cause the local demineralization of the enamel surface. Unless the process is stopped, the final consequence is a continuing tooth destruction. The equation can demonstrate the interaction of all these factors: the microbes + saccharosis is equal to acids + plus receptive tooth surface is equal to dental caries. Frequency and time length of this interaction is one of the main causes of the caries development.

It is not possible to exclude the influence of other factors that are essential for the origin of dental caries, for instance the individual host resistance against the dental caries is influenced also by the level of the secretoric imunoglobulin SIgA in the saliva. The level of fluorides in the saliva is important as well, the difference by the size of 0,01 ppm can decide about the rate of succceptibility to the dental caries.

The dental caries can be prevent by a number of preventive measures. The caries prevention consists above all in these methods:

- the raise of enamel resistance to the dental caries
- the affecting of the cariogenic bacterial mikroflora
- the affecting of the diet parts that imagine the nutritious substrate for bacterias

The occurence of the dental caries will be in the concrete individual lower according to the number of the abovementioned factors that will be influenced by the used prevention methods.

The basic presumption for arising a healthy dental tissue is a normal undisturbed development of the child's organism. That is why the protection of pregnant mother and protection of the child from unhealthy influences and diseases and a proper diet are the main requirements in the caries prevention.

The developing organism needs sufficient and ballanced intake of all basic nutriments that means: albumen, oils, sugars, minerals and vitamins. From the minerals, fluorine shows a remarkable influence to the quality and resistance of the tooth tissue. The possibility of affecting of the diet and the microflora requires the active cooperation of the informed and motivated individual who is permanently able to respect recommendations given by the dentist.

The dental caries is a dynamic process with periods of demineralization and remineralization. The enamel is in favourable conditions in a dynamic balance with the saliva which is in regard to the enamel overfed with calcium and phosphate ions. Saccharides from food are in places with a presence of bacterial plaque fermented by the plaque microorganisms and the

acids are turned out. The plaque pH is falling down and the condition of undersaturation with calcium and phosphate ions quickly arises in the tooth neighbourhood. That is why these ions have a tendency for diffusion out of the enamel.

As soon as pH is going up the saliva shows the ability to transport the calcium and phosphate ions back to the enamel (including fluorine if it is present) and the ion balance will move toward to the remineralization.

This fluctuation of pH balance passes through every time when the mouth environment is changing as an answer to food intake (diet factors) and to oral hygiene. In the case the ion exchange on the enamel surface inclines during a certain time towards to demineralization, the surfaces of enamel prisms in the subsurface enamel layer are dissolved at first and the surface enamel layer remains relatively intact. Spaces among the prisms of subsurface enamel layers arise and that is why this area starts to be more porous. This fact is the cause of changes the optical property of the enamel, it makes the enamel opaque and the starting caries lesion in the form so called white spot lesion or chalky spot is coming into being.

Diet and dental caries

Orientation in the area of the diet consultancy has to be a part of the basic knowledge of the dentist. These reasons are important:

- optimal diet balance is necessary for healthy development of human individual and for preserving of the health in adult age
- often sugar consumption is in the direct cause continuity with the dental caries origin
- bad habits that cause a more often dental caries occurrence lead to advancement of obesity, arteriosclerosis, high blood pressure and diabetes mellitus as well
- the diet habits from childhood can be only very difficult changed in adult age
- requirements for ratio diet are in good accord with general recommendation for healthy support
- our basic duty is to motivate a patient in the diet region. The motivation leads to the prevention of stomatological diseases

The diet composition shows two manners of activity in relationship to dental caries occurrence: we determine the **preruptive** and **posteruptive** effect of the diet. In many tendencies these two effects are difficult to separate exactly.

Preruptive effect of the diet and the dental caries occurrence

Composition of diet takes part after absorption in the gastrointestinal tube especially in the development of the hard dental tissues and their mineralization. The unbalanced diet composition can raise the susceptibility (predisposition) for dental caries origin by the way that it doesn't make the optimal chemical and structure construction of hard dental tissues possible. The mineralization disorders can be expressed in changes of enamel hardness, its permeability and solubility which are important for dental caries creation. Insufficient mineralized areas in dentin can make the faster enlargement of the caries process possible. The supply especially of calcium, phosphorus, fluorine is needful during the time of development and mineralization of hard dental tissues. A sufficient saturation with albumens, sugars, oils and vitamins is a self-evident demand. From this point of view the critical period

for primary dentition development is between the 12th week of intrauterine development to the 2nd year, for permanent dentition development the critical period j.kuklová

is between the 24th week of intrauterine development until the 15th year of life. It is evident that the optimal diet must be given not only to child but to pregnant and breastfeeding mother as well.

The diet composition effects the saliva amount (quantity) and composition (soft x hard food), the saliva applies its character after teething.

The important points in continuity to dental caries inception are: malnutrition (undernourishment), vitamin D supply, calcium and phosphorus rate, fluorine supply, supply of other trace elements.

Malnutrition – generally can lead to later teething of primary and permanent dentition, influences the saliva quality as well.

Vitamin D – its lack can lead to the hypoplastic defects in primary dentition and by this way to the increase in dental caries occurrence in primary dentition

Calcium and phosphorus rate – the optimal rate is important after teething

Fluorine and other trace elements – important is the positive task of fluorine in dental caries prevention

Posteruptive effect of the diet and the dental caries

-local effect directly in the oral cavity, it is much more relevant to dental caries occurrence than the preruptive effect. The influence directly to the hard dental tissue is the most deciding in the caries process. Saccharides are the most important diet part in the affinity to the dental caries. Saccharides are mostly of plant origin and they are the most important energy resource for the human being. Three basic groups of saccharides – mono, oligo and polysaccharides. All of them are part of the normal human food. Microorganisms in the dental plaque use the mono and oligosaccharides (lactose, glucose, fructose, sucrose) directly for acids formation, polysaccharides (starch) are used for acids formation after their degradation by saliva or by bacterial amylases to maltose.

Dental caries and monosaccharides, oligosaccharides

Sucrose (sugar-beet or cane sugar) is situated to the top place among all saccharides in the relationship to the dental caries development. Sucrose is our basic sweetness. It represents substrate for formation of extracellular polysaccharides which represent an ideal environment for microbes growing. The cariogenic activity of saccharides depends not only on their intake to the body but also on the whole taken amount, on the form and frequency of the used saccharides intake. Relationship between saccharides intake and dental caries development can be demonstrated on situations with no or very low amount of saccharides in food and on situations with oversize supply.

The low content of saccharides – prehistoric human bodies, low sugar rate consumption during world wars

The high content of saccharides – a very extensive and serious damage in primary dentition can be found even in suckling and toddler age after offering various sweetened drinks from a baby bottle. Some parents give sweetened drinks to the child as a soothing toy, the children are falling asleep with a bottle in the mouth. In the case the child is thirsty the water is the best beverage. Early childhood caries ECC, (baby bottle caries or rampant caries) has a typical succession: primary incisors in the upper jaw, first primary molars in the both jaws, following by incisors in lower jaw, all canines and in the end the second primary molars.

Dental caries starts as a white spot lesion on the vestibular surface or in the approximal surface, then the cavitation starts and develops and caries enlarges to be circular, often together with bad oral hygiene. The incisal unimpaired part of the crown above the circular caries will
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break off during falling down, after hard bite or not very consequential stroke. The parents often don't give the dental situation in the frontal upper jaw to the relation with the oral hygiene and using of sweets but only to the relation with the injury.

Swenander-Lanke in 1957 instituted the „**sugar clearance**“ term. This author proved that a lot of facts are very important for remaining of saccharides in the oral cavity: concentration, solubility, adhesion to the hard dental tissues, degree of the enzyme degradation of saccharide and ability to stimulate the saliva secretion. The sugar clearance value was assessed for many nutrients.

The method „**telemetry of dental plaque pH**“ is more precise for determining of the cariogenic activity of separate kinds of nutrients than the sugar clearance method. It is done with help of the glass microelectrode which is fixed to the pHmeter and taking-off denture. The scientists in Switzerland as first introduced a term „*zahnschonend*“ – teeth saving product according to this method. After taking of this product the dental plaque pH value will not fall down under $pH=5,7$ during 30 minutes.

Cariogenic potential is conditioned by the content of saccharides (amount and kind). Cariogenic effect depends on the individual diet habits, nourishment demands, on the saliva quality and on the oral hygiene quality.

Dental caries and polysaccharides

Polysaccharides are in the human food found in form of starch in potatoes, cereals and pulses (leguminous plants). The starch grain is in the natural form only very bad dissolvable and it is only slowly disintegrated by saliva amylases. Starch in natural condition can have a protective effect regarding to caries process development also by the way that chewing of fibres can very expressively support the salivation.

This situation is essentially changed after modification of the food with starch content by cooking, freezing or by extrusion. The microbes in the dental plaque are after such way of modification able to produce acids but the amount of acids is lower than the amount after saccharosis intake. In the case that the thermally adjusted starch food is sweetened the acids production is the same as the food contained only saccharosis. The same pH drop in plaque under the critical point $pH 5,5$ will appear.

Saliva

The determination of the saliva pH contributes to information supplements about the cariogenic situation in the oral environment. The measure and time when the pH value is staying under the critical border $pH 5,5$ after the food consumption are influenced by a whole factors complex. These factors are especially:

- content of saccharides in diet
- buffer capacity of the saliva
- content of minerals and saliva proteins for its assessment

Consequently this value is very variable and it is necessary to repeat the assessment measure of the immediately capacity in the dependence of eating time and daily time. The indicating paper strip or electronic pH-meter can be used for establishing the pH value.

The drop of the pH value under the critical border comes after each food intake because the acidogenic microorganisms of dental plaque very quickly change the exogenous saccharides to acids. The resulting change in the plaque pH passes through according to so called j.kuklová

Stephans curve. The course of this curve is to a certain extent influenced by diet habits and salivation rate which is individually very different and variable.

Dental caries and milk, cheese

Milk and cheese are important parts of the rational nourishment. Mother milk is in normal circumstances the only child food after birth and sugar in this milk is the main source of energy for the child. Milk contains lactose, this type of saccharides is cariogenic as well but less than saccharose. Milk contains minerals (especially calcium and phosphorus), proteins and fats and these components of milk affect against dental caries. The dangerous situation will occur when the child is falling asleep during breastfeeding and mother let the child sleep in this position, especially after teething. Many children at the age of toddlers are frequently breastfed during night. This situation looks like falling asleep with baby bottle with sweet drinks inside. This situation doesn't correspond with breastfeeding in suckling age. The rests of sweet mother milk remains on the labial surfaces of upper primary incisors, the saliva secretion during sleep is physiologically lower and in the end the caries destruction of teeth starts, the consequence is similar to ECC diagnosis.

Cheese are pronounced to be protective food in consideration of dental caries development, the hard cheese is more important. Cheese expressively raise the salivation and the calcium concentration in the plaque as well.

Dental caries and fruits, fruit juices

The sugar portion in fruits and fruit juices and the texture of these products are the most deciding factors. Dried fruits bring the pH of dental plaque down as well. Fresh fruit and juices can damage hard dental tissues by acids that are contained inside. Juices and also high energetic drinks that are drunk in small amounts and frequently lead to high caries risk. Citrus fruits frequently eaten can cause erosions of the hard dental tissue, most often on the palatal surfaces in the frontal upper teeth.

Noncariogenic sweetness and dental caries

Substitution of cariogenic sugars is useful not only from the stomatological point of view but also in the case of necessity to reduce the body weight and in cases of various metabolic disorders. Common requirements for sucrose substitutes:

- cariogenic effect must be considerably reduced or eventually excluded
- no undesirable taste
- tolerance for human body
- usability in grocery technology
- usability in other medicine areas, especially in diabetology and dietology
- sweetness is comparable to sucrose

The sucrose substitutes can be divided into two groups:

1. Caloric sweeteners – nutritious = sugar alcohols and their mixtures

sorbitol

2. Sweeteners without energy value – nonnutritious = artificial products

natural products

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Caloric sweeteners

Sugar alcohols and their mixtures are the most wellknown of them. In 1969 the sugar alcohols were recommended by the WHO as sweeteners for people suffering from diabetes mellitus. Sugar alcohols as natural metabolic products are widely spread in flora and fauna (vegetable, cereals, fruits, others). They are recommended also for people that want to reduce their sugar intake.

Sorbitol – the mostly used caloric sweetener. The majority of dental plaque microbes is not able to utilize it for acid production. Sorbitol is the most important sweetener for people suffering from diabetes mellitus. It can be used in grocery industry – chewing gums, chocolates, ice-creams, soft drinks.

Xylitol – even relative small doses 4-10g create an effective protection against caries process. Xylitol is able to raise the saliva secretion, to raise the amylase and peroxydase level in saliva. It is used in production of chocolates, chewing gums and other sweets, it is even a part of toothpastes.

Manitol and mantitol have similar properties as sorbitol

Isomalt is a mixture of two sugar alcohols – sorbitol and manitol in ratio 1:1. Its energetic value represents about 50% of sucrose energy value.

A higher amount of sugar alcohols that would be eaten at the same moment can cause gastrointestinal problems. The daily dose couldn't be higher than 70g (at adults) .

Lycasin - the combination lycasin and xylitol is seen to be optimal.

Sorbose – true sugar among nutritious sweeteners. It has a low fermentability, the streptococci in the oral cavity are not able to utilize it.

Nonnutritious sweeteners = sweeteners without energy value

In consideration of the chemical structure they are not able to cause caries process.

Aspartam – dipeptide. It consist of fenylalanin and aspagar acid. It is nearly 200times more sweet than sucrose. It is able to intensify effects of all components in the case it is in small amount added to sucrose, glucose or saccharin. The low stability is the aspartam's disadvantage. Aspartam is most constant in temperature 20 degree C and pH value 3-4,5. Aspartam doesn't tolerate long warming. It can be used in milk and grocery industry, drinks. People suffering from fenylketonuria are prohibited to use it.

Thaumatococin was isolated from plants. It has slightly liquorice taste, it can be used as a sweetener of beverages and farmaceutic products.

Saccharin is the longest time used sweetener. It was invented even 1879. It is warmly stabil, cheap and it is not utilised in the body. 98% is excluded by urine without any change.

Cyclamates were used for drinks, food, mostly in saccharin combination. They are metabolized to toxic cyclohexylamin in the human body, that is why they are prohibited in many European countries.

Acesulfame-K (Sunett) is not metabolized in the human body, it is excluded by urine. The taste is fresh sweet. It is chemically and termo stabil, it can be used in beverages, chewing gums, sweets. It is given to the toothpastes and mouthrinses as well.

Noncariogenic sweeteners substitute saccharosis especially in products that are assigned for children – chewing gums, syrups, candies. Above all xylitol but also sorbitol and manitol are held in chewing gums. The saliva that is secreted quickly during chewing is alkaline, it supports the neutralization and aid the mineralization.

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Aliment pyramid

Aliment pyramid presents visually principles of correct nourishment, not only in the relation to dental caries. It also reflect the present view to nourishment with respect to weight and eventually to reduction of weight in a given individual.

The top of the pyramid is created by fat, oil, sweeteners and salt, the doctors recommend a temperance with these products.

The remaining parts of the pyramid represent 5 basic aliment parts which are necessary to be in balance found on our tables. The base-line of the pyramid is constituted by whole-corn products, this cereal group is bringing vitamins and fibre like as fruits and vegetables. It would be favourable to eat 3-6 portions of these products a day, one portion is represented by slice of bread, croissant (better made from dark flour or whole-corn), one portion of rice or pastries.

It is recommended to eat 3-5 portion of vegetable and 2-4 pieces of fruit a day.

Three daily portions go to milk and milk products, they are source of calcium and albumen. The low fat products are recommended, 1 portion = a quarter liter of milk, yoghurt, 50g of cheese or 40 gramms of a Cottage cheese. These aliments are very important in childhood, they should represent 4-5 portions. Milk products should represent 3-5 portions in pregnancy and during breastfeeding.

The group of fish, poultry, leguminous plants (pulses), eggs and not fat meat represents sources of albumen, iron and nonsaturated fat acids. 1-3 portions should be eaten a day.

The common recommendations:

- food has to be as varied as possible
- natural table waters are the best beverage. It is important to eat as much fruit and vegetable as possible
- people should prefer dark bread and whole corn bakery products to white bread
- it is important to reduce the fat consumption. Lard and butter should be changed by plant oils. Plant oils should be used not very often and not very much as well
- it is better not to eat fried dishes and tin dishes, not to consume sausages
- consumption of red meat should be shortened, it is better to eat fish and poultry
- it is necessary to reduce the diet rich of cholesterol (eggs fat meat, fat milk products)
- it is important to raise the consumption of aliments rich in vitamins and fibres
- it is important to shorten the consumption of sugar and to stop eating of salt food as chips and saltened nuts
- alcohol drinks should be drunk temperately, the wine should be preferred to beer

- it is necessary to hold the adequate body weight
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