Ozone Treatment of Initial Lesions

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Summary

Caries is a disease of hard dental tissue caused by the following factors: host (the tooth), cause (microorganisms), environmental influence and time. With improved technology new, contemporary, methods of diagnosing caries lesions have been introduced, one of the most important being laser fluorescence. Parallel with the development of new diagnostic methods, the classical "Black's principle" of cavity preparation, was replaced, first with "minimally invasive non-traumatic dentistry", and more recently with "ozone therapy". Bactericide and disinfective properties of ozone enabled a new concept of "painless therapy" in treatment of caries lesions.

Key words: *caries, diagnostics, ozone therapy.*

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Introduction

Dental caries is a disease of hard dental tissue that occurs dynamically, through complex physico-chemical processes that over a certain time period cause destruction of the hard dental tissues. Causative agents of caries are acidogenic microorganisms that, together with ability to produce organic acids, also possess other cariogenic characteristics (ability to populate surface enamel and create extracellular and intracellular polysaccharides). The widest spread cariogenic microorganism is *Streptococcus mutans*. Besides it, many other species, for example Lactobacilli and Actinomyces also participate in caries formation. Populating the tooth surface or plaque creation takes place in several stages. In the first stage, pellicle forms, a thin glycoprotein membrane without cells and bacteria. The second stage is characterized by the initial bacterial colonization of aerobe and facultative anaerobe bacteria, mostly consisting of Streptococci (*S. mutans, S. sanguis, S. mitis, S. salivarius, and S. sorbinus*), Neiseria and gram-positive rods. During this stage, aerobic conditions still persist in the plaque matrix so the breakdown of glucose takes place in the citric acid cycle with carbon dioxide and water as the final products. The third stage or formation of mature plaque is characterized by an increase in the production of extracellular polysaccharides dextran, levan and mutan, that cause increase in the plaque volume and decrease its permeability. Newly formed anaerobic conditions favor Fusobacteria, Actinomyces, filamentose bacteria, and gram-negative cocci. A consequence of the anaerobic conditions is a breakdown of carbon hydrates on to pyruvic i maleic acid. Accumulation of acidic metabolites significantly lowers pH values in plaque, which causes demineralization of the enamel and initial lesion formation (1).

Demineralization is a melting process of hydroxyl apatite crystals while remineralization is a process during which calcium, phosphates, fluorides and other ions precipitate from the saliva or from inside the lesion and then recrystalize. In other words, demineralization is a process that damages enamel while remineralization restores it.

Natural remineralization process is important for decrease in caries incidence because it changes, slows down and even stops demineralization as well as replaces the mineral mass of enamel created during demineralization process. Both processes continuously interchange in the natural caries lesion and remineralization can often be activated while demineralization still happens (2).

In dental systems of developed countries great emphasize is placed on preventive treatment, and implemented necessary therapeutic procedures are minimally invasive. The goal is for the treatment to be as fast, and simple as possible, pleasant for the patient and as cheap as possible.

One of the most important tasks in the modern concept of dentistry is the early detection and treatment of an initial lesion. Even though an initial lesion represents already several years of developed stage of caries, it is still possible to stop the lesion from developing further, and achieve partial or complete replacement of the lost minerals.

Because of the structural and morphological irregularities in pits and fissures, the risk of occlusal caries development is increased in relation to other tooth surfaces. Occlusal caries represent the main portion of the total caries. Caries diagnostics of fissures became more difficult because of the wide use of fluoridation, which caused the caries process to be slow progressing, with possible remineralization of the initial lesion (3).

For a long time dental probe and mirror were the main diagnostic tools used in detection of occlusal caries. Diagnosis of occlusal caries was based on tactile sense during probing, and views of dentists greatly varied in interpretation. In teeth with no visible signs of cavitation, probing or sticking of the probe into the fissure develops mostly because of specific fissure anatomy, and not because of the caries presence.

Diagnosis of occlusal caries is made more difficult because of the remineralization of the enamel above the dentinal lesion. Lesions grow bigger without visible cavitation in the fissure, because fluoridated enamel is less susceptible to fractures and collapse than non-fluoridated. Intraoral shots have an important role in diagnosis of the caries lesion, especially obtained by the “bitewing” technique.

Digital radiography or automatized computer systems also help in the detection of occlusal lesions. Digital radiography more effectively detects deep lesions in dentin that require immediate treatment (4).

Air abrasion technology of cariogenic tissue removal was developed during the 1940’s. By releasing microscopic particles of non-toxic abrasive powder under pressure, this procedure enables fast removal of the enamel, dentin, caries and previous fillings. Air abrasive systems decrease heating, vibrations and bone sound conductivity, characteristic of conventional caries removal methods. This method removes stain and organic debris in the fissure in the preparation for the sealing of the fissure. Air abrasive technology presents new possibilities in the diagnosis and treatment of occlusal caries (5).

According to research, the best suited diagnostic tool for the early detection of occlusal caries that possesses excellent ability to locate dental caries underneath the fissures and acceptable ability to identify non-cavitated fissures, is measurement of electric resistance. Electric conductivity of the teeth changes with demineralization even when the surface stays macroscopically intact. Electric resistance measurement in the diagnosis of occlusal and dentinal caries proved to be a good method. Devices for electrical resistance measurement test only one point while Roentgen film encompasses the entire occlusal surface. Considering additional loss of time and complex procedure during clinical measurements, it is better suited for use as an additional diagnostic test.

Technological development introduced new laser fluorescence based systems for early caries detection. This type of device measures laser fluorescence of dental structures by pointing the laser light of 655 nm wavelength onto the occlusal surface using an optical fiber probe. Fluorescence of the tooth structures affected by the caries is proportional to the degree of caries. Fluorescent light intensity, transferred to numerical values is expressed on the screen of the device (6-9).

One of the devices based on this principle is DIAGNOdent (KaVo, Dental GmbH, Germany) (Figure 1). Advantage of this device in caries diagnostics lies in the following; easy application, objectivity in diagnostic interpretation, non-invasiveness and possibility of early detection of demineralization areas (Figure 2, 3). This device can also provide important information when it is used for monitoring a demineralized area over a certain time period. Repeated control can accurately determine possible changes (10).

New trends show a rise in the number of procedures that attempt to substitute the classical surgical approach in removing caries affected dental tissue and creating a cavity with the use of rotating instruments, a procedure often unpleasant for the patient. New, minimally invasive techniques have been introduced that remove only infected and demineralized dental tissue and are aimed at biological protection of the tooth structure (11, 12).

Such a new approach posed the question of whether it is justified and necessary to implement a strictly classical approach, primarily on the principle of preventive extension and sacrifice healthy tooth tissue in order to achieve macromechanical anchoring of the restorative material in the cavity.

Today it is thought that classical cavity preparation is necessary only in cases of uncontrolled demineralization of dental tissue and in high caries risk patients. In that case, surgical approach means removal of infected and destructed dental tissue, replacing it with suitable material capable of substituting lost tissue, filling the cavity and ensuring normal mastication as well as plaque control.

Recently, a new device HealOzone (KaVo Dental GmbH, Germany) (Figure 4) was introduced on the market offering a new, non-traumatic concept in the treatment of caries lesions. It consists of a generator, ozone, vacuum pump, unit for neutralization and a rubber hose with a handpiece on which silicone caps are applied. The silicone cap is placed on the caries affected tooth enabling the creation of an impermeable layer or the so called vacuum effect (Figure 5, 6a, b) (13).

Ozone has a virulent, bactericidal and fungicidal action. For some time it has been used in the treatment of rheumatic and skin diseases, and more recently in dentistry. Its purpose is to enable healing of caries effected tissue using biologically active substances. This mode of action effectively destroys the caries causing bacteria inside as well as on the surface of the tooth and the high disinfectant action enables healing (14, 15).

Safe usage of ozone is ensured in the form of an applicator that determines the field of ozone action, and at the same time vacuums extra ozone back in. Since ozone application is possible only with correct placing of an applicator, any harmful action of ozone on the patient and therapist is prevented.

Research shows that:

- Treatment with HealOzone 10 sec eliminates 99% bacteria
- Treatment with HealOzone 20 sec eliminates 99.9% bacteria
- In most cases of root caries and caries in fissures remineralization occurs within 4-12 weeks
- No side effects

Ozone rapidly activates microorganisms causing rupture of the cell membrane. Potential toxicity of the ozone should not prevent its use for therapeutic purposes, because in the correct dosage it can be a very effective therapeutic tool (16,17).

Use of HealOzone

Application of Ozone during posteruptive stage (first year)

Application of Ozone enables thorough elimination of *S. mutans* from the masticatory surface. Research shows that ozone application inhibits bacterial recolonization for the following three months. This is especially important if the enamel at the bottom of the fissure is thin or insufficiently formed.

Application of ozone in the case of defective (damaged) mineralization

In case of irregularities in the mineralization of hard dental tissue, use of ozone can be very beneficial because the defective area is a predlective place for sedimentation of *S. mutans* (i.e. fluorosis). In the case of tetracycline defects, the effect of ozone is low because the enamel surface is intact.

Application of ozone before fissure sealment

The fissure system is an ideal place for sedimentation of *S. mutans*. Ozone application before sealment greatly benefits removal of bacteria from plaque in a deep fissure, which prevents occurrence of caries beneath sealing materials.

Application of ozone on initial lesions (as a sign of early colonization)

Restorative procedures in children are often difficult. If that is the case, ozone application presents a non-invasive and painless alternative. In some cases, the fissure system is treated with glass-ionomer cements that release fluorides with depo-effect and induce remineralization.

Application of ozone on early caries in children (bottle caries)

Bottle caries is caused by the constant use of the bottle. Ozone therapy can be implemented to stop further growth of an already formed lesion and avoid classical caries sanation, which can be quite difficult at such an early age.

Application of ozone on demineralized tooth surfaces

Demineralized surfaces on buccal and lingual smooth surfaces represent a predilective site or a high caries risk area. Ozone application on demineralized surfaces enables sealing of a caries cavity deep in the lesion. This is especially successful in smooth areas where remineralization is better. Proximally, application of ozone is difficult because it is not always possible to achieve a vacuum effect.

Use of ozone is connected with remineralization and it is necessary to emphasize that extra application of remineralization solutions or pastes after the therapy results in a higher success rate, especially in patients with poor dental hygiene (Figure 7). Single ozone application in some cases does not show immediate results and it is necessary to repeat the treatment in about 4 weeks. Nevertheless ozone is a very effective accessory means for the prevention and therapy of caries (13, 16, 17).

Further clinical and laboratory studies of HealOzone should confirm its effectiveness in specified clinical situations as well as open up the possibility of its use not only in cases of initial lesions and cavity disinfection but also in disinfection of the root canal and whitening of discolored dental crowns.