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Selected unconventional methods of caries treatment. Literature overview

The most popular method of treating carious changes in teeth is that of using a dental borer. However effective, this conventional method, based on a slow- or high-speed drill, is highly unpleasant to all patients, irrespective of their age. Very often patients complain of pain during the procedure. The fear of feeling pain is the most common reason of putting off the visit at the dental practice. Together with a high sound intensity, vibrations are perceived as noise and thus constitute an additional stress factor which may provoke unpleasant sensations (7, 13). Due to all the abovementioned elements, new methods allowing for stress- and painless management of carious changes, have thoroughly been searched for.

OZONE THERAPY

Certainly, ozone therapy is a method which needs to be investigated more closely. Ozone is a natural component of the atmosphere. It is present at the height of around 30 km in the stratosphere as a result of ultraviolet rays acting on oxygen. It is a colourless gas giving off acrid, characteristic smell. It can be found in all physical states. In its liquid and solid states, ozone is a highly explosive substance, as a temperature-dependent gas it shows a tendency to disintegrate (16).

For medical purposes, ozone was first used in 1870 by C. Landler. E. Lynch, Professor of the Conventional Dentistry and Gerostomatology Department at the Queens University of Belfast, is said to be the father of ozone therapy in dentistry. Thanks to its physicochemical properties, ozone can be used for dental therapies as it: • improves metabolism of infected tissues by means of its oxidizing effect • activates the reaction of immunological systems – in high doses it has a depressive effect and in small doses – a stimulating effect on the immune system • influences the general oxidation of the body • causes the destruction of bacteria, it also has fungicidal and virucidal properties.

Being a strong oxidiser, ozone enters into reaction with bi-molecules containing cysterine, cysteine, methionine and histidine which serve to build cellular membrane of the bacteria. The main object of its attack become thiol groups of cysteine amino acid. The research has shown that ozone used for only a few seconds on the bacteria leads to their death. Unlike Gram-negative bacteria, Gram-positives are more sensitive to ozone. Stronger resistance to its influence is also shown by the bacteria containing bacterial capsule. The most sensitive carious bacteria are *Streptococcus mutans* and *Streptococcus sobrinus*.

Ozone therapy is widely used to cure infections caused by anaerobic flora. Thanks to its oxidizing effect on some proteins, it helps to destroy the cellular membrane of the carious bacteria in teeth.

The scientific study has proved that ozone enters into reaction both with carious bacteria and with their metabolites. Ozone causes oxidation of bacteria metabolites and makes them impossible to use by the developing bacterial flora. Moreover, it easily affects multiunsaturated fatty acids in the virus capsules and reacts with ascorbates and tocopherols • Ozone has some whitening effect and it helps to remove unpleasant smell • Acting on the organic substance of the tissue in the mineralized teeth, it increases their ability to remineralize. It is at the same time able to "open" dentinal channels and thus to facilitate the diffusion of calcium and phosphorus ions to deeper layers of carious cavities.

According to the majority of sources, over 10 sec of the ozone influence on the surface of the primary carious change of the tooth root reduces the bacterial flora by 99% and for 20 sec – 99.9%. What is thus created is the so-called ecologic niche which does not render re-colonization of bacteria in the period from 4 to 6 weeks. The short action time does not allow for resistance intensification.

The maximum allowable concentration of ozone is 0.05 ppm, and it cannot be applied for more than 8 h a day. In the oral cavity, its concentration should not exceed 0.01 ppm (2, 15, 16). The development of the HealOzone technique made it possible to use the curing properties of ozone in dentistry. It is specially effective while treating the primary carious changes. The HealOzone device takes oxygen from the air and turns it into ozone which is then applied on the infected tooth. The tooth is protected and therefore isolated from healthy teeth by the tight silicone cap. The flux of ozone through the infected place is very fast (inside the cap, ozone is exchanged 300 times per sec). It kills all the bacteria in just 10 to 40 sec. A quick elimination of the bacterial flora destroys their ecologic niche. The fluid initializing remineralization, containing phosphorus and calcium compounds, as well as phosphates and xylitol (10, 17), is then rubbed in the ozoned surface of the tooth.

Ozone therapy can be used in the following areas of the conventional dentistry: caries prevention; furrow caries; primary caries of biting surfaces, tooth enamel and the dentinal surface; any type of primary caries, including root caries; medium and deep caries treatment, as a high-standard complementation to the mechanic development; enamel fractures; tooth neck oversensitivity. Contraindications: patients with pacemakers, as well as those suffering from asthma, epilepsy or other neurological illnesses; small children and pregnant women; cavities which are difficult of access and in which the tightness of a cap is impossible to maintain (2, 17).

In their studies, Holmes et al. stated that after 12 months of ozone therapy the condition of 99% of primary carious lesions gradually improved. The control test was carried out by means of DIAGNOdent device (5). Johnson and others conducted research on primary tooth caries, as well. After 1 month of ozone application on the teeth surface, 59% of cases showed improvement in the clinical test and 41% did not exhibit any change. Experiments with DIAGNOdent device demonstrated no exacerbation of carious changes (9). The experimental procedures proved moreover that after the therapy with ozone and some remineralizing materials, the development of primary root caries can be stopped on the level of rough change. Once they had been stopped and remineralized, the carious changes do not become activated any more (provided that the prophylaxis is managed in a proper way) (6). A great amount of the recently published literature demonstrated a high efficiency of ozone local bactericidal properties combined with a subsequent application of remineralization-triggering compounds in stopping carious changes (1, 3, 5, 15).

The latest technology allows greater comfort, lesser amount of stress and time economy. The method is simple and is not work- or material-consuming, either (10). What is more, in the last few years, no side-effects of the ozone therapy using HealOzone device have been noticed in any of the European research centres or dental clinics (6).

Disadvantages of the ozone therapy: 1) the problem of maintaining the ideal tightness between the cap and the ozoned tooth; the device does not administer ozone when there is a risk of untightness; 2)

much time (even 10 min) needed for a proper application of the cap; 3) the construction of the device hinders the treatment of lesions class II and III – then opening by means of a drill is necessary (17).

In the future, the ozone therapies will surely be one of the best prophylactic methods of caries treatment. It also seems obvious that in the light of the current achievements and general knowledge on ozone properties, the therapy using ozone as a therapeutic means can be safe and effective only when the rules concerning its safe exposition, dosing and application are observed (10).

AIR ABRASION

The second alternative method of treating carious lesions is air abrasion. This method has been used for quite a long time. In 1942, Dr Robert Black started his research on the air abrasive methods in dentistry and in 1945 he published a series of articles concerning their use in caries treatment and prevention.

To eliminate caries, the air abrasion method uses the stream of concentrated bundle of aluminum particles granulated in a non-uniform manner. These particles move with a proper kinetic energy created by the pressure. When they meet a hard tooth tissue, the oxide aluminum particles give back the energy via their actions. In consequence, enamel and dentine are successively abraded. Multiple repetition of this process results in the total elimination of caries from the treated tooth. The efficiency of the air abrasive method depends on the aluminum particles' size, shape, hardness and thickness, as well as on the air pressure (4, 7, 12, 14).

The greatest advantages of air abrasion, highlighting its superiority to other methods, are: 1) lesions treatment with no need of anesthetizing the patient; 2) no vibrations – there are neither damage of hard tissues and pulp of the tooth, nor unpleasant experiences for the patient caused by vibrations; 3) no pressure on tooth and the sterility of procedure – the abrasion is a non-tactile method; 4) contrary to the drill management, there is no temperature growth in the tissues under development. Impulse work of the device, which after throwing out the portion of oxide aluminum automatically cools down the surface under development with a stream of compressed air, eliminates this problem and does not make the pulp irritated even in case of deep lesions; 5) no microfractures in the hard tissues as the filling is more tight; the characteristic sticky layer or oil coming from turbine tips in particular, is no longer present. Thanks to its elimination, complications connected with untight fillings, such as after-operational hypersensitivity, secondary caries, inflammation and the pulp necrosis, do not exist; 6) the degree of adhesion of tooth tissues to the filling is increased due to: creating the mechanical microretention on the surface of the processed tissues, obtaining a clean, sticky layer- and oil-free surface, which results in a bonding of superb quality; 7) shutting off or decreasing the light of dentinal channels results in the lack of reaction of the pulp on mechanical, thermal and chemical impulses, as well as in a reduced penetration of bacteria and a limited vaporisation of the tissue liquid. There is no risk of the dentine getting too dry; 8) the economic processing of healthy tooth tissues allows for lesser tissue removal than while applying a conventional drill (14).

Disadvantages of the method under study: 1) no real feeling during cavity preparation because there is no contact between the nozzle and the surface of the tooth. The above is connected with the fact that a doctor has to predict the border of carious cavity, which carries the risk of incorrect preparation of the carious dentine (12), 2) the dustiness which appears during the preparation calls for using a cofferdam, aspirator, system of filters, a mirror which is resistant to abrasion or face masks (8).

The experiments concerning the time rate of caries elimination by means of the air abrasion and drill methods have been conducted. While air abrasion was more effective in case of shallow caries, the drill was preferred to process deep caries (12). The experiments as to the level of feeling pain during cavity preparation by means of the air abrasion method gave the following results: According

to Jadczyk et al., 33.3% of patients felt no pain during the air abrasion procedure, in 40% of the cases the patients felt little pain, while in 26.6% they suffered from pain of a higher degree. Pain of strong intensity was not stated. Goldberg found that 50.3% of the patients treated with this method did not feel any pain, while 40.6% acknowledged pain of weak intensity. Hamilton discovered that in a group of 93 patients subjected to the air abrasion method only 14 people asked for an anaesthetic (4, 7).

The air abrasion is a universal method and can be used on a very wide scale. The indications to apply this method in conservative treatment of teeth are the following: caries of all classes, the cavities that call for precision in tooth tissues preparation, the microcavities – a very exact and economic processing of a carious spot, children caries, handicapped children caries, procedures carried out with children suffering from chronic fear of the dentist, the preventive correction of the dental fissures' shape, preparation before sealing instead of etching, caries of the pregnant, especially when there is a risk of miscarriage, procedures carried out with patients oversensitive to pain, procedures carried out with patients oversensitive to drill noise and vibrations, procedures that are supposed to exert the minimum harm on the tooth tissues, safe preparation of cavities with orthodontic patients using permanent apparatuses (12, 14).

Contraindications: bronchial asthma or chronic bronchi inflammations, inflammations of gums or mucous membrane of the oral cavity, allergy to aluminum oxide (13, 14).

Taking into consideration the advantages resulting from cavity preparation by means of air abrasion method, it has to be said that the method is a serious competitor to a drill and thus it can be widely recommended.

HIGH POWER LASERS

The high power lasers can also constitute an alternative to the traditional preparation of cavities. Such lasers are devices with continuous or medium radiation power starting from 500 mW. The lasers of this group are applied to induce controlled destructive processes of tissue including: cutting, vaporization, coagulation and photoablation. Effectiveness of inducing these processes in the biological tissues depends on a proper selection of such parameters as: energy or power of radiation, width of impulse or time of tissue contact, absorptive proprieties of tissue as well as thickness or power of the laser radiation (11). There are mainly two high power lasers which are used for hard tooth tissues processing: 1. Er: YAG laser, 2. Nd: YAG laser. For the first time laser was used in dentistry in 1964. However, the preparation of hard tooth tissues by means of a laser was first attempted in 1966. Experiments concerning the treatment of caries with the Er: YAG laser began in 1989 (18). Nd: YAG laser emits 1,064 nm long wave which is led to the operating field by a flexible optical fibre which is 0.2 mm wide.

Advantages of the method: 1. Laser reaches any tissue; it is really precise in dosing energy and can therefore eliminate tissues infected by caries, leaving healthy tissue intact, which testifies to its better control of dentine removal than while using traditional turbine drill. 2. The laser rays effectively seal up the dentinal channels, which helps to reduce after-operational hypersensitivity. 3. Laser irradiation in primary caries causes remineralisation of the demineralized enamel. 4. The process of laser processing is practically painless because the time of impulse duration is shorter than the time necessary for stimulating the receptors and creating a nervous impulse. 5. Laser use before filling by means of making the surface of bonding for indirect resins larger, eliminates effectively the need of etching the cavity with the phosphorous acid.

Research conducted in the 1960s–1980s has proved that because of lesser procedure efficiency and thermal side-effects, lasers should not be used in the cavity preparation. The use of Er: YAG laser was a considerable breakthrough for the laser therapy in the conservative dentistry: 1. High

effectiveness of enamel and dentine removal by means of microablation – a microexplosion without pitting the edges of lesions occurs in the point of contact between the laser and the tooth tissue. The individual arrangement of hydroxy apatite in the enamel remains intact. 2. The procedure is carried out in a non-tactile and painless way, with the use of a water spray. The typical system of cooling by means of a water spray additionally helps prevent the surface from heating up and therefore increases the radiation efficacy. 3. Even during the procedure of opening the tooth chamber, the dentine processing with the use of a laser does not bring about irreversible changes in the pulp. 4. The laser can be applied to remove fillings made of composite materials and amalgams.

A poll conducted among patients treated with laser showed that all of them perceived this method as less painful and less stressing than any of the traditional methods of preparing cavities by means of a mechanical drill. Eighty per cent of the patients declared that they had felt no pain during the laser work, 13% felt slight piercing pain and 7% notified little pain which concerned cavities with deep caries during preparation of chamber wall. The complex use of Er: YAG and Nd: YAG lasers in prophylaxis and caries treatment can be perceived as a great breakthrough in dentistry. The research defined their properties as useful and harmless to the dentine and enamel. No unfavourable influence on the pulp has been detected, either (11, 18, 19).

The three methods of carious cavities' preparation have much more advantages than disadvantages. No doubt, their greatest benefit is the possibility of almost painless treatment of teeth, which constitutes the milestone in the conventional dentistry. The majority of patients, especially those with a negative attitude towards the dental treatment, will surely approve the new, stress-free methods that will help them overcome their fear of the dentist.

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SUMARY

On the basis of publications, selected unconventional methods of carious lesions management, i.e. ozone therapy, air abrasion and high power lasers, were discussed. The analysis comprised a list of advantages and disadvantages of these methods and a presentation of scientific research confirming the usefulness of such methods in the treatment of carious cavities.

Wybrane niekonwencjonalne metody leczenia próchnicy zębów. Przegląd piśmiennictwa

Opierając się na piśmiennictwie, omówiono niekonwencjonalne metody opracowania ubytków próchnicowych: ozonoterapię, abrazję powietrzną i lasery dużej mocy. W opracowaniu uwzględniono zalety i wady oraz przedstawiono badania naukowe potwierdzające przydatność tych metod w leczeniu ubytków próchnicowych.