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Modern Methods of Caries Diagnosis and Treatment: Review of Innovative Technologies

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Abstract: In this paper modern methods of diagnostics and treatment of caries are studied: review of innovative technologies, examples of hardware methods of diagnostics are given. They are compared with each other, advantages and disadvantages of each method are taken into account.

Keywords: Caries, diagnostics, efficiency of laser fluorescence, optical coherence tomography and electrical impedance spectroscopy.

Introduction: Purpose of the work: : to carry out a comparative characterization of caries diagnostic methods.

As it is known, today caries is one of the most widespread diseases in the world (over 95% of people) . Diagnosis and prevention of carious process development are still considered important and not fully understood problems in modern dentistry. It has been proven that caries is a multistage process that requires a combination of risk factors and time to form a cavity. It is often the case that it is not always possible to diagnose the carious process or the risk of caries at a dental appointment. In most cases, when a patient comes to the dentist for help, he or she already has cavities, which leads to preparation of tooth tissue and subsequent filling. The task of dentists today is to maximize the preservation of own tooth tissues, to prevent the pathological process at an early stage of its development. There are various objective tests for detection of cariesogenic situation (COSRE, TER-test, CRT-test), various methods of caries detection (basic and additional), but when used separately they are uninformative and doubtful. Diagnosis of caries in a

more accessible and faster way at early stages of its development remains one of the urgent problems in modern dentistry.

Caries is one of the most common dental pathologies affecting people of all ages. Modern methods of diagnostics and treatment of caries are rapidly developing, which makes it possible to detect the disease at early stages and carry out sparing treatment. This article reviews innovative approaches to diagnosis, including laser fluorescence, optical coherence tomography, and electrical impedance spectroscopy. Current treatment methods such as enamel infiltration, laser preparation, and remineralizing therapy are also analyzed.

Caries is a pathological process that leads to demineralization and destruction of the hard tissues of the tooth under the influence of microorganisms. According to the World Health Organization (WHO), more than 90% of the adult population suffers from dental caries. Traditional methods of diagnosis (visual inspection, radiography) and treatment (preparation and filling) have a number of disadvantages, including invasiveness and the need to remove a significant part of the tooth tissue. In this regard, a relevant direction of modern dentistry is the development of new diagnostic and therapeutic approaches that minimize intervention and preserve healthy tissues.

Diagnosis is an important aspect of clinical medicine, without which it is impossible to make a diagnosis, hence the difficulty of subsequent prescription of treatment and preventive measures. Of primary importance in the detection of caries is early diagnosis, when the patient has no complaints. This is due to the fact that previously detected defects are easier to eliminate, and thus it is possible to prevent the progression of the pathological process. Due to the early manifestation of the carious process in the absence of diagnosis, the intensity of dental caries may increase from a CPUE of 2.7 (2004-2006) to a CPUE of 3.5 (2011) [2] in all age groups of the population. It should be assumed that the fundamental solution to this problem is the study of modern approaches to diagnosis and its subsequent implementation to detect the early stages of the carious process

1. Modern methods of caries diagnostics

1.1 Laser fluorescence (DIAGNOdent)

1.2 The method of laser fluorescence using the DIAGNOdent diagnostic device (KaVo, Germany) allows to detect changes in the structure of tooth tissues in the process of demineralization mainly on the occlusal surfaces of teeth. The laser photodiode of the device emits light waves of 655 nm length (red radiation) and a threshold power of 1mV onto the tooth surface. Organic and inorganic molecules of the tooth hard tissue absorb the light, and reflection by the device in the infrared spectrum occurs. As a result, the device gives values in numbers and notifies with an audio signal. For higher accuracy of readings, it is recommended to clean and dry the tooth before diagnosis. In case of poor oral hygiene, presence of abundant plaque, the device may produce incorrect values. The main advantages of this method are ease of use, the absence of harmful ionizing radiation, detection of hidden carious cavities, recognition of fissure caries. Also, with the help of digital and sound identification it is possible to clearly determine the severity of the disease. However, the device is not intended for diagnostics of contact surfaces of teeth, as in most cases it is not possible to introduce the tip of the device into the interdental space. This significantly reduces the scope of application of this device [20-22]. Another option for caries diagnosis is the Quantitative Light-induced Fluorescence (QLF method). The Quantitative Light-induced Fluorescence apparatus is based on the decreased ability of tooth hard tissue to fluoresce when demineralization occurs. The appliance is a portable intraoral system with an incoherent light source and a filter system to replace the laser source. The light-emitting system generates blue light with an intensity of 370 nm, which is transmitted through a liquid-filled light guide. During the examination, the tooth absorbs the pulsed blue light, so that healthy teeth glow green and decayed teeth glow red. The image of the fluorescing tooth is transmitted to the monitor using a video camera through a high-pass filter. The screen displays a color image showing the condition of the patient's oral cavity. The device is designed for early detection of carious lesions due to loss of fluorescence in zones of demineralization, determination of localization, depth and size of the carious cavity, as well as the severity of the pathological process. Thus, introduction of new methods of caries diagnostics into clinical practice will allow to prevent further development of carious process at early stages, as well as facilitate treatment by applying non-invasive techniques without preparation with preservation of own tooth tissues.

Laser fluorescence is one of the most accurate and non-invasive methods of detecting caries. The principle of operation is based on the ability of demineralized tissues to emit fluorescent light under the influence of a laser. The DIAGNOdent device allows detecting carious lesions at early stages, especially in hard-to-reach areas, such as the fissures of molars.

Advantages of the method:

- High diagnostic accuracy

- No radiation exposure
- Possibility of monitoring the dynamics of the process

1.2 Optical Coherence Tomography (OCT)

This method is similar to ultrasound but uses light waves. OCT provides highly accurate real-time images of tooth structure, revealing even minimal enamel damage.

Advantages:

- High resolution
- No ionizing radiation
- Early detection of lesions

1.3 Electrical Impedance Spectroscopy (EIS)

The method is based on measuring the electrical impedance of the tooth tissue. Affected areas have altered electrical conductive properties, which allows a high degree of accuracy in diagnosing demineralization.

2. Modern methods of caries treatment

2.1 Enamel infiltration (ICON-technology)

Infiltration therapy is intended for treatment of initial stages of caries without mechanical removal of tissues. The method is based on the use of a polymeric material that penetrates the porous enamel, sealing the affected area.

Advantages:

- Painlessness of the procedure
- Preservation of healthy tooth tissue
- High aesthetics

2.2 Laser preparation

Laser technology is gradually replacing the traditional drill. Lasers (e.g. Er:YAG) provide highly precise removal of carious tissue, reducing patient discomfort.

Advantages of the method:

- Painless
- Minimal damage to surrounding tissues
- Sterilizing effect of the laser

2.3 Remineralizing therapy

The use of preparations containing fluoride, hydroxyapatite and calcium-phosphate compounds can strengthen the enamel and stop the process of demineralization.

CONCLUSION

Thus, the introduction of new methods of caries diagnostics into clinical practice will prevent further development of carious process at early stages, as well as facilitate treatment by applying non-invasive techniques without preparation with preservation of own tooth tissues.

Application of modern methods of diagnostics and treatment of caries allows not only to detect the disease at early stages, but also to conduct therapy with minimal invasiveness. Laser technologies, infiltration techniques and biomimetic materials open new perspectives in dentistry, allowing to effectively fight caries and prolong the life of teeth.

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