THE PHOTODYNAMIC THERAPY IN THE TREATMENT OF DENTAL CARIES: NEW OPPORTUNITIES IN THE CONDITIONS OF GENETIC DETERMINATION OF THE CARIOUS DISEASE

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Abstract

The purpose of this phase of research is the foundation of the use of photodynamic therapy in the treatment of deep caries of acute and chronic forms of people with a high degree of genetic determinism to it. Materials and methods. Researches are based on the observations of 162 patients aged 18–25 years who have caries with a high degree of genetic determinism to carious disease at A (II) B (III) Rh. They were divided in groups. Group selection depends on the clinical flowing of deep caries and using antiseptic treatment with photodynamic therapy. We used a 0.1 % aqueous solution of toluidine blue as photosensitizer. It was irradiated by low-energy of dental diode laser (Elexxion Claros Pico laser, Germany). A wavelength was 635 nm, output of 100 mV, a dose of energy -1.8 J. Results and discussion. We determined that the use of PDT improves the effectiveness of treatment and improves the forecast of treatment of acute deep caries in people with its genetic determination. However, the feasibility inclusion of PDT in the treatment algorithm for chronic deep caries flow is not defined. Conclusions. We proposed the differentiated tactical approach to treatment of acute dental caries. It contributes to increase the efficiency of personified secondary prevention of caries including its genetic determination.

Keywords: photodynamic therapy, photosensitizer, acute deep caries, chronic deep caries, genetic determination to carious disease.

1. INTRODUCTION

The relevance of the prevalence, effectiveness of caries disease prevention and its complications keep on taking the important place among the problems of dental health in population of the East countries, including Ukraine.

According to the data of WHO, the caries prevalence in the most countries ranges from 80 to 98% and it is progressing to 100% in the countries with low level of life [1]. The significant material resources of the health care systems of the most European countries are spent to the primary prevention and treatment of carious disease on the individual and communal levels [2, 3]. Due to this fact, the fight with carious disease in such countries is carried out mostly with secondary prevention.

In other words, the main tactic of dentists includes the application of new innovative technologies for preparation and antiseptic treatment of carious cavities (Beta Cave, Slot, laser method, the vector system and air-abrasive treatment, the use of ICON, Heal-ozone, etc.) and the implementation of different levels of technological materials in practice for fillings [3, 4].

The micro refining aggression of the dental lesions occupies a significant place among the factors of high prevalence and resistance measures for secondary prevention of caries disease.

It is a major factor in the development of the slow type hypersensitivity to microbial antigens, which authentically potentiate the autoimmune mechanism of many serious dental and somatic diseases, including first of all the systematic destruction of connectivetissue with autoimmune pathogenesis factor - rheumatoid arthritis (9.5 M, ICD-10), rheumatism (79.0 M, ICD-10), glomerulonephritis, systemic dermatostomatytis - lichenplanus (L 43.9, ICD-10), erythema multiform (12.0 K, ICD-10), etc. [1].

On the other hand, the development and implementation of new high technical filling materials which are used in the treatment of caries represents a reason of controversial issues
about the need and appropriateness for drug treatment of carious cavities. Some researchers see no points in the antiseptic treatment of cavities at a depth of affection in within the enamel-dentine border and surface dentine [5]. The others speak categorically about the necessity of using drug-treatment regardless the depth of cavity [6]. There is no clear answer regarding the feasibility of the antiseptic treatment depending on the character of the caries process. At the same time, this aspect is still not investigated in people with different degrees of genetic determination to the carious disease.

Antiseptic substances that are traditionally used for the cavities treatment for cavities before filling are often dangerous to pulp. Also they often disrupt the polymerization of laying and renewable materials and they have only a bacteriostatic effect and does not create a sterility of the cavity. Another negative feature is that they are incompatible with therapeutic liners [7].

Significant controversy appeared in the cases of the use of antiseptic substances in cavities located within the pulp (deep) dentin during the acute flow of the pathological process. And the same in the groups of people who are determined to the caries blood group antigen system A (II) B (III), Rh - [8].

In recent years, some works about the feasibility inclusion of photodynamic therapy (PDT) as a new strategic direction phase of the secondary prevention caries disease appeared. The use of PDT can be attributed not only due to its impact on the vast majority of pathogenic bacteria in cavities, but also because of the activation of microcirculation in pulp as a result of the regulatory effects on microvascular laser radiation [9].

The essence of photodynamic reaction is in formation of free radicals or short-term living forms of singlet (Active) oxygen. The formation in the cell where there is a photosensitizer, free radicals and / or singlet oxygen causes the cell damage with its further death. In terms of implementation of photodynamic reactions we should state that singlet oxygen and free radicals are short-term living forms and they get inactivated during the million parts of a second, breaking for the outcome and components and therefore they don’t cause danger for the other cells [10].

The most important feature of interaction of biological tissues with the molecules of photosensitizing agents is in its selective consumption only by “harmful” cells of the organism. It is possible to keep normally functioning cells and to destroy abnormal cells, which were an obstacle for the activity of the whole body. The type of such “bad” cells is defined by the hyperactivity of their metabolic activity which exceeds their normative level of cell operation [11, 12].

We have not found a clear, reasonable strategy of PDT application in the treatment of deep caries of acute flow in the literature. We consider that exactly this state needs a sighting study. It is because the reactive inflammation in the pulp when a person has deep caries without compensatory reaction of the pulp during the acute carious processes in the area around the pulp dentin can be significant factor. And it defines the future results of carious disease with the development of a number of complications.

In this connection, the aim of the present phase of our researches was the justification for applying of PDT in deep caries treatment with acute and chronic flows in patients with high degree of genetic determinism.

**The following tasks were set:**

1. To investigate the closest and remote results of applying PDT for antiseptic treatment of carious cavity in patients with acute deep caries who have a high risk of the determinism.
2. To evaluate the closest and remote results of the PDT inclusion for antiseptic treatment of carious cavity in a deep caries treatment with a chronic flow in patients who have a high degree of its genetic determinism.

**2. MATERIALS AND METHODS**

We used the clinical, radiographic, odontometric, immunogenetic methods (for definition of the group system of ABO (H) Rh) which were applied for the selection of the patients to participate in our researches and to evaluate the quality of the treatment.

162 patients aged 18-25 who addressed concerning caries to the medical center of Bogomolets NMU were under our supervision.
The first clinical group consisted of 82 patients (50.62%) patients with diagnosis of acute deep caries (C 02.1, ICD-10). The second clinical group consisted of 42 (25.93%) patients with chronic flow of the disease. The photodynamic therapy (PDT) was used as an antiseptic treatment of cavity for the patients of both clinical groups.

The two groups were the control groups of patients. Both of them have 19 people each and both have people with acute and chronic caries (III and IV groups, respectively). PDT was not made for them.

According to the informative agreement, the patients with carious cavities were chosen to participate in the research. They were patients with caries of 16, 17, 25, 27, 36, 37, 46 teeth and first class of definition to Black’s classification of caries. Also they belonged to the group of people with a high degree of genetic determinism (for A (II) B (III), Rh-). All patients had satisfactory hygienic condition of the oral cavity (OHI-S <0.5).

The same treatment, lining and restoring materials were used for unification of the treatment in all groups. The acute deep caries was treated in two visits, the chronic one – in one visit. The lining techniques were applied in all groups.

The nano-hybrid photo-composite was used as a permanent filling material. The curing liner was introduced by calcium-containing material on the casein-based. The lining technique included traditional insulating liner.

The traditional way of cavity preparation without application of the alternative technologies were used in all groups.

The 0.1% aqueous solution of toluidine was used as a photosensitizer during application of PDT. It was put in the prepared carious cavity and irradiated by a low-energy laser radiation of the modern dental diode laser «ElexxionClaros Pico» (Germany) with a wavelength of 635 nm, output power- 100 mV, a dose of energy - 1.8 J.

3. RESULTS AND DISCUSSION

As a result of the made researches in the first group (acute deep caries with the usage of PDT) in 70 patients (85.37%) we marked the satisfactory treatment reached in the closest and the remote terms (safekeeping of fillings, absence of complications in pulp, retained full functional ability of the tooth). At the same time, in the third group (control group -acute deep caries without using of PDT), the number of the satisfactory results was significantly lower in the remote terms and was 68.42%. The negative result determined by loosing of fillings in 4 people (21.05%) and by the development of chronic fibrous pulpitis in 2 people (10.53%).

It is determined that in the second group (with chronic deep caries and the inclusion of PDT) and the fourth group (with chronic deep cries and without the inclusion of PDT) the immediate and remote results of the treatment were satisfactory in a relatively large number of the patients.

36 patients which made up 85.71% of the investigated people of this group and 17 people of the control group (respectively 89.47%) did not depend on the inclusion of PDT in the treatment scheme. So, the PDT application did not change the number of positive results. We should note that one patient in the second group there had complications in the form of secondary caries. Two people were marked with the development of chronic fibrous pulpitis. In the fourth group, 2 patients had the loss of filling with the further development of chronic fibrous pulpitis. We assume that the appearance of some small number of cases with adverse outcome could be caused, on the one hand, by caries-determination, on the other - possible changes in general health, and as a result - the negative treatment outcomes.

So, it is established that the inclusion of PDT or the rejection of it in the algorithm of deep chronic caries treatment did not affect the immediate or remote treatment outcomes.

4. CONCLUSIONS

The analysis of the closest and remote results of the caries treatment in individuals with genetic determination by the blood group markers of A (II) B (III) Rh - has shown the necessity and feasibility of introducing the PDT treatment in the treatment schemes of the pathological process in the conditions of acute flow.

The effectiveness of combined with the PDT therapy is confirmed in 85.38% of cases, which
gives the rationales to assert about the possibility of a positive prognosis of treatment.

It is proved that the patients with the chronic dental flow with the affected around-pulp dentine have no expediency for using PDT for the purpose of antiseptic treatment of cavity.

We consider that the dose of laser radiation 1.8 J (It was grounded with the data of the previous researchers [11, 12]), makes it possible to obtain the satisfactory results and to predict the remote outcome of carious disease. Also it is an adequate strategic and tactical approach to the persons who belong to caries-determined groups by genetic blood markers A (II), B (III), Rh.

The obtained data let us to define the role and the place of PDT as an antiseptic treatment of dental hard tissues in operative and restorative dental treatment. Also it would contribute the efficiency of personified secondary prevention of caries based on its genetic determination.

The research perspectives are in development of differentiated approaches to choice of optimal parameters of PDT in tooth decay treatment and prevention, particularly in people with its genetic determination.

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