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APPLICATION OF PHOTODYNAMIC THERAPY IN TREATMENT PROTOCOL OF PLAQUE-INDUCED GINGIVITIS IN CHILDREN.

Paediatric Dentistry

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ABSTRACT

Objective: To evaluate the effect of photodynamic therapy in the treatment of plaque-induced gingivitis in children. **Materials And Methods:** The study included 34 children with plaque-induced gingivitis, aged between 10 and 14 years, divided into two groups:1) Control group with mechanical periodontal therapy (18 children); 2) Experimental group with additional photodynamic therapy (16 children). Oral hygiene status was assessed using the FMPS index, and gingival status was evaluated using the SBI. The treatment protocol included 4 visits with three photodynamic therapy sessions. **Results:** At the end of the therapeutic period, plaque accumulation levels were found to be twice as low compared to the baseline in all children (FMPS – 32.25±5.99 in the experimental group and 29.78±11.32 in the control group). The sulcus bleeding index decreased with a greater reduction in the experimental group (0.37 ± 0.22). **Conclusions:** Photodynamic therapy demonstrates its therapeutic effect in the treatment of plaque-induced gingivitis in childhood and leads to a significant improvement in gingival status in children aged 10-14 years.

KEYWORDS

Photodynamic therapy, gingivitis in children

INTRODUCTION:

Gingival diseases are the second most common oral diseases diagnosed in childhood and adolescence [1]. Often, improperly developed oral hygiene habits during early adolescence, combined with the specifics of the period until the stabilization of the periodontium, are the most common cause of increased microbial load in the dental biofilm and the development of gingival inflammation in children.

According to the latest classification of periodontal diseases, plaque-induced gingivitis affects all children in whom more than 10% of gingival units show provoked bleeding [1].

Clinically, the initial gingival inflammation in adolescents is characterized by changes in the color, volume, and consistency of the gingival tissues, accompanied by the presence of bleeding on probing, which rarely causes discomfort and usually does not bother the children. Over time, without symptoms, the inflammation advances, and the clinical condition deteriorates. Microbial activity increases subgingivally, and pathogenic periodontal strains develop, which aggressively participate in the pathological process [2].

In the treatment of this type of oral pathology in children, the goal of pediatric dentists is to reduce the microbial load by limiting plaque accumulation, which is achieved through mechanical periodontal therapy until a healing process in the gingival tissues is reached. However, Harper et al. found that the recolonization rate of subgingival microorganisms after mechanical periodontal therapy is relatively quick, taking about a week for the microorganisms to return to baseline levels before treatment, especially when not combined with measures for individual plaque control [3]. Literature survey show that the use of additional antimicrobial agents in parallel with mechanical periodontal therapy leads to a significant reduction in microbial load and delays the recolonization of periodontal pathogens [4]. Both local antimicrobial therapy and photodynamic therapy can serve as adjuncts against microorganisms in the dental biofilm.

Photodynamic therapy (PDT) has antimicrobial effects and is widely used in dental medicine – for the treatment of mucosal diseases, in cariology, endodontics, as well as in the treatment of periodontal diseases. Numerous studies have been conducted worldwide regarding the effectiveness of photodynamic therapy as an adjunctive treatment for periodontal pathology [5, 6].

Photodynamic therapy involves photosensitizers that absorb light of a specific wavelength. The excited molecule of the photoactive substance leads to the formation of two types of reactions that occur simultaneously. In type 1 reaction, the photosensitizer reacts with nucleic acids, lipids, and proteins of the bacterial cell and transfers an electric charge that produces radicals. These radicals react with molecular oxygen, leading to the formation of specific oxygen species such as hydrogen peroxide, hydroxyl radicals, and superoxide anion. In type 2 reaction, the photosensitizer in its excited triplet state transfers energy to oxygen in its ground triplet state, forming singlet oxygen. Due to its short half-life, singlet oxygen ensures a local effect of photodynamic therapy, making it suitable for application on localized areas of the gingiva without affecting distant cells and tissues [7].

Multiple author groups have found a positive effect of PDT both on the clinical parameters of periodontal status and on the composition of subgingival microorganisms [8, 9, 10,11].

However, the literature also presents conflicting results, which do not establish a positive effect from the influence of adjunctive photodynamic therapy in the treatment of periodontal pathology [12,13,14].

The majority of global studies, however, have been conducted on adult patients or those with inflammatory-destructive changes in the periodontal space. This gives us the basis to investigate the effect and impact of the combination of mechanical periodontal therapy and PDT in the treatment of plaque-induced gingivitis (PIG) in adolescents.

Objective:

The aim of this study is to evaluate the impact of photodynamic therapy in the treatment of plaque-induced gingivitis in children aged 10-14 years.

MATERIALS AND METHODS:

Material

The study included 34 children with plaque-induced gingivitis (PIG) aged between 10 and 14 years.

Inclusion Criteria For The Children In The Study:

- Signed informed consent from parents for participation in the scientific study approved by KENIMUS with protocol No. 12/14.05.2020.
- Bleeding on probing in more than 30% of the gingival units, which according to the current classification of periodontal diseases, includes patients with generalized plaque-induced gingivitis [1];
- No systemic diseases;
- No antibiotic use in the last 3 months;
- No non-removable orthodontic appliances.

The Children Were Divided Into Two Groups According To The Treatment Protocol:

- **Control Group Without FotoSan** - 18 children treated according to the described protocol without additional photodynamic therapy;
- **Experimental Group With FotoSan** - 16 children treated according to the described protocol with additional photodynamic therapy – 3 procedures.

Other Materials Used In The Study

An electronic periodontal probe **PA ON (Orangedental)** with accompanying software was used to assess the gingival status of the

children and select participants for inclusion in the study.

In the treatment of plaque-induced gingivitis in the children of the experimental group, the **FotoSan One Patient Perio Kit GOLD PLUS** photodynamic therapy kit was used.

METHODS

1. DiagnosticMethodology

All children included in the study underwent a clinical periodontal examination in 4 levels according to the methodology adopted by the Department of Pediatric Dentistry. The clinical examination were conducted in a dental office, and the clinical data were stored in the software of the electronic device.

To assess the oral hygiene status, the **Full Mouth Plaque Score (FMPS)** index was used. For this purpose, a plaque indicator solution was applied, and the presence/absence of dental biofilm on all permanent teeth in four fields – distal (distovestibular), medial (mediovestibular), vestibular, and oral – was recorded. The index is automatically calculated by the software of the periodontal probe and shows the relative percentage of surfaces with plaque for each child.

To assess the gingival status, the **Sulcus Bleeding Index (SBI)** was used. All fully erupted permanent teeth were examined. The values on the scale from 0 to 5 were recorded in the first and third quadrants vestibularly, and in the second and fourth quadrants lingually. After entering the data, the software automatically calculates the numerical value of the sulcus bleeding index for the patient [15].

2. Treatment Methodology

The sequence of treatment procedures and follow-up of children with plaque-induced gingivitis included a total of 4 visits, which are schematically presented in the following table (Table 1).

Table 1: Treatment Protocol

Visit Group	**1 visit**	**2 visit** (7 day)	**3 visit** (14 day)	**4 visit** (30 day)
Control group without FotoSan	1.Periodontal examination; 2. Initial periodontal therapy.	1. Reassessment; 2.Professional plaque removal and polishing.	1. Reassessment; 2.Professional plaque removal and polishing.	Reassessment
Experimental group with FotoSan	1.Periodontal examination; 2. Initial periodontal therapy; 3. Photodynamic therapy with FotoSan.	1. Reassessment; 2. Professional plaque removal and polishing. 3. Photodynamic therapy with FotoSan.	1. Reassessment; 2. Professional plaque removal and polishing. 3. Photodynamic therapy with FotoSan.	Reassessment

3. Photodynamic Therapy Methodology

The protocol for adjunctive antimicrobial photodynamic therapy included the following stages:

- Application of the photosensitizer using a syringe with Medium viscosity along the gingival margin or in the gingival sulcus of all teeth (Fig. 1 – left);
- Activation of the agent with a photodynamic therapy lamp (in red working mode) (Fig. 1 – right) and a Blunt attachment mounted on it. The photoactivation lasts for 10 seconds for each surface of the tooth – two buccal and two oral surfaces.
- Removal of the photosensitizer with an aspiration cannula and rinsing of the oral cavity with water.

Fig. 1 Application of the photosensitizer (left) and activation of the agent with FotoSan 630 (right)

RESULTS:

1. Dynamics of the Oral Hygiene Index "Full Mouth Plaque Score" (FMPS) during treatment.

The following table presents data on plaque accumulation in the children of both groups during the course of treatment (Table 2).

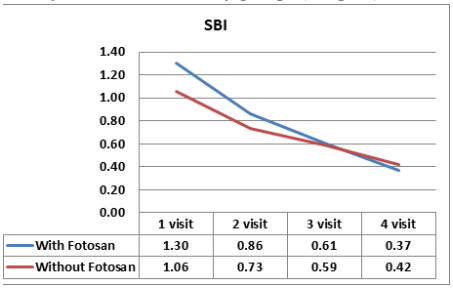
Table 2: Plaque Accumulation During Treatment

Group	N	FMPS				
		1 visit	**2 visit** (7 day)	**3 visit** (14 day)	**4 visit** (30 day)	Paired Sample T test
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
With FotoSan	16	66,31± 26,25	23±5,35	43,06±1 8,23	32,25±5, 99	p<0,05
Without FotoSan	18	59,61± 19,78	20,67±7,6 0	32,06±1 5,03	29,78±11 ,32	p<0,05
Total	34	62,76± 22,94	21,76±6,6 4	37,24±1 7,28	30,94±9, 16	p<0,05
Independent t test		t=0,846 p>0,05	t=1,022 p>0,05	t=1,929 p>0,05	t=0,781 p>0,05	

From the table, it is clear that 7 days after the start of treatment, the relative percentage of tooth surfaces covered with plaque is nearly 3 times lower in all examined children compared to the baseline. This is due to the effect of the performed mechanical periodontal therapy, which is part of the initial phase of treatment for gingival inflammation. After professional oral hygiene, re-motivation, and additional photodynamic therapy in the FotoSan group, a slight increase in the index is observed after two weeks (14 days), although it does not reach the initial values. At the end of the therapeutic period, levels of the index are found to be twice as low compared to the baseline in all children. The FMPS index values during treatment in both groups are similar ($p > 0.05$).

2. Assessment of Gingival Inflammation Using the Sulcus Bleeding Index (SBI).

The following chart presents the dynamics of the sulcus bleeding index (SBI) values by visit in the two study groups (Graph 1).



Graph 1: Dynamics of the SBI by visit in the two groups

From the graph, it is clear that the values of the SBI index decrease gradually during the second visit. This is most likely due to the time required to control the inflammatory process in the tissues. By the 7th day, the index values drop below 1, which is a clear indication of a healing process. Two weeks later, in both groups, the index values (0.60 ± 0.43) are already twice as low as the baseline values ($t = 1.27$, $p > 0.05$), with a more significant decrease in the index values in the FotoSan group compared to the control group. Most likely, the cumulative effect of the performed photodynamic therapy positively influences the healing process.

In contrast to plaque accumulation, the values of the sulcus bleeding index SBI demonstrate a gradual decrease throughout the treatment period. This indicates that there is a noticeable difference in the dynamics of plaque accumulation and the healing process in the gingiva. This is likely due to the mechanical periodontal therapy, which begins the treatment and leads to a sharp reduction in microbial load. The change in the microbial ecology in the subgingival space is a necessary condition for completing the healing process in the gingiva, and this is enhanced by PDT.

DISCUSSION:

The aim of this study was to evaluate the impact of photodynamic therapy in the treatment of children with plaque-induced gingivitis. The results we obtained showed that in both groups we studied, the plaque accumulation values decreased drastically during the second visit, which can be explained by the performed mechanical periodontal therapy. During the next visit (14th day), a slight increase in the index values was observed, but they remained approximately 30% lower than the baseline values. At the end of the therapeutic period, the

plaque accumulation values in the FotoSan group decreased more compared to the control group. We assume that this is due to the effect of PDT, which, on one hand, has a direct bactericidal effect on bacterial cells, and on the other hand, affects the polysaccharide matrix of the dental biofilm, indirectly destroying the protective layer of bacterial microcolonies [8].

Similar results were obtained by another research group that tracked the effect of adjunctive photodynamic therapy in the treatment of plaque-induced gingivitis in children undergoing orthodontic treatment. They recorded a decrease in plaque accumulation values on days 7 and 15, followed by a gradual increase, though not reaching baseline values [16]. Al Nazeh et al. also, like us, observed a decrease in plaque accumulation on the second week, which continued to decline even one month after therapy [8]. This indicates that PDT creates unfavorable living conditions for bacterial colonies in the biofilm, which is a prerequisite for a faster healing process.

In contrast to plaque accumulation, the values of the index reflecting gingival status show a gradual decrease, characteristic of the healing process in the gingival tissues, throughout the treatment period. It is important to note that the sulcus bleeding index (SBI) values in the FotoSan group show a more significant decrease compared to the control group at the end of the therapeutic period.

We can conclude that during the treatment of children with plaque-induced gingivitis, we observed relatively quicker achievement of index values corresponding to periodontal health in the group with adjunctive PDT. This can be explained by the cumulative effect of consecutive FotoSan procedures. This suggests that PDT influences the composition of the dental biofilm and its pathogenic potential over time, which is also proven by other authors [17, 18, 19, 20]. The proven high sensitivity of members of the orange complex in Socransky's classification to PDT is likely key in managing inflammatory changes in the gingiva by changing the microbial ecology during treatment [17].

A research group that tracked children with gingivitis, divided into two groups – Group 1 with only mechanical periodontal therapy and Group 2 with additional photodynamic therapy – did not find differences between the two groups at the end of the therapeutic period. The scientists believe that the lack of difference in the two groups is due to the application of a single session of photodynamic therapy, in contrast to our study, which included three FotoSan applications [8].

A study of the effectiveness of photodynamic therapy was also conducted by other authors investigating children with gingivitis who had concurrent blood disorders. The children were followed up at 6 and 12 months, with the researchers finding significantly lower gingival index values in the group that received photodynamic therapy [21]. Christodoulides et al. compared the effects of mechanical periodontal therapy with the effects of adjunctive photodynamic therapy. The authors found that in the group receiving photodynamic therapy, significantly lower values for provoked gingival bleeding were registered compared to ours, with follow-ups at 3 and 6 months [13].

CONCLUSION:

The results obtained from our study show that photodynamic therapy demonstrates its therapeutic effect in the treatment of plaque-induced gingivitis in childhood and leads to significant improvement in gingival status in children aged 10-14 years.

The antimicrobial effect of adjunctive photodynamic therapy most likely leads to a change in the microbial ecology of the subgingival biofilm, which positively affects the healing process compared to standard periodontal therapy.

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