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Impact of Photodynamic Therapy Applied by FotoSan[®] on Periodontal Tissues' Clinical Parameters

REVIEWED PAPER

Most patients visiting dental surgeries suffer from various types of periodontopathies. Since the discovery of the role of biofilm in the etiopathogenesis of periodontal diseases, we have been trying to influence its reduction.

Key words: photodynamic therapy, photosensitizers

Abstract: The article describes a study carried out in order to determine the impact of photodynamic therapy on periodontal tissues' status and delivers general information regarding this treatment.



FotoSan System

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The “Golden Standard”, i.e. scaling and root planing - SRP, not always meets clinicians' expectations. Fortunately, mechanical cleaning finds support thanks to developments in science and technology. Nowadays SRP can be aided by the use of photodynamic therapy.

PHOTODYNAMIC THERAPY

Photodynamic therapy (PACT - photodynamic antimicrobial therapy) uses the phenomenon of excitation of photosensitizer (a ring-structured chemical substance) by a light wave adapted to its absorbing spectrum, which results in releasing singlet oxygen ($^1\text{O}_2$) and other so-called reactive forms of oxygen.

Photosensitizers are: methylene blue, toluidine blue (derivatives of phenothiazine, used most frequently in dentistry), porphyrins, acridine

dyes, chlorins, phthalocyanines and psolaren derivatives. Lasers and LEDs can be sources of exciting light.

Possibilities of using PACT in eradication of pathogenic microorganisms (bacteria, viruses, *Candida* fungi and protozoa) are currently under investigation.

PHOTOSENSITIZERS

Unstable singlet oxygen acts only topically, without the risk of affecting sites distant from the site of its application. Photosensitizer excitation results in destruction of cell membranes and walls, proteins, nucleic acids, bacteria, viruses, protozoa and fungi.

Despite the beginnings of photodynamic therapy date back to the turn of the 19th and the 20th centuries, its use in dental treatment does not have such a long tradition. Its *in vitro* effect is relatively well documented.

SCIENTIFIC RESEARCH

Qin *et al.* (2008) studied toluidine blue (TB) efficacy as photosensitizer used with a 635 nm laser as light source. Toluidine blue showed the highest efficacy in 1 mg/ml concentration at 12J/cm² and 159mW/cm² laser parameters, however the authors suspect that in *in vivo* conditions (bacteria organized in biofilm structure are far more resistant than plankton forms) both the photosensitizer concentration and light source power should be increased (1).

Fontana *et al.* (2009) studied the effect of PACT on dental plaque reduction. Specimens of dental plaque were collected from 10 patients with chronic periodontitis. During the study the sensitivity of bacterial biofilm and plankton forms to photodynamic therapy was assessed. The specimens were subjected to photosensitizer activity (methylene blue) for 5 minutes and exposed to red light. The study showed a 63 percent death rate of plankton bacterial forms and 32 percent death rate in bacterial biofilm. In conclusions to the study a lower efficacy of the therapy for bacterial biofilm was noted, however it was pointed out that the therapy was still much more effective compared to antibiotic therapy in similar conditions (2).

In *in vitro* studies the safety photodynamic therapy on host's tissues was assessed. Soukos *et al.* (2000) reported that administration of poly-L-lysine and chlorin e-6 (which are germicidal for *P. gingivalis* and *A. viscosus*) is not cytotoxic for mucosal membrane cells in oral cavity (3).

Kömerik *et al.* (2000) when studying lipopolysaccharide (LPS) suspension of *E. coli* bacteria and *P. aeruginosa* protease proved that PACT is capable of reducing their biological activity (4). The *in vitro* study results were confirmed in *in vivo* animal model studies and in clinical studies on patients.

De Alemida (2008) on the basis of conducted experiments (assessing by histological and radiological examinations the photodynamic therapy's impact on periodontal tissue parameters in rats) proposes to apply photodynamic therapy as auxiliary element of traditional periodontal treatment (5).

Qin *et al.* (2008) in their research compared the efficacy of photodynamic therapy and traditional SRP. The assessment included the total bacterial count and histological picture of periodontal tissues (6).

The first group was subjected only to toluidine blue activity in 1 mg/ml concentration and to 12J/cm² red light laser, the other group was subjected only to scaling and root planing. The results in both groups were similar, i.e. they showed a significant reduction of: bacterial count, plaque index (PI), reddening and bleeding on probing (BOP), inflammatory infiltration of soft tissues, without noticeable side effects.

The results of the study indicate a significant efficacy of photodynamic therapy with the use of toluidine blue (comparable to "golden standard" i.e. scaling and root planing) and its high potential with reference to periodontal treatment.

Similar conclusions were formulated by Kömerik (2003) - an examination with toluidine blue, additionally indicating a significantly smaller alveolar bone loss in the group treated with photodynamic therapy (7).

In vivo studies also confirmed safety of photodynamic therapy on the cells of epithelium, dentine, pulp and alveolar bone. [Lusan *et al.* (2009)] (8).

One of the available PACT systems is FotoSan[®] device (CMS Dental[®]).

FOTOSAN (CMS DENTAL[®]) EFFICACY - CLINICAL TESTS

Aim

The aim of the study was to assess the efficacy of photodynamic therapy applied by FotoSan[®] on clinical parameters of periodontal tissues.

Materials and Methods

The study included 40 patients between 35 and 70 years of age with diagnosed chronic periodontitis and with minimum 10 own teeth. The patients were recruited from persons treated in Department of Periodontology and Oral Diseases.

The exclusion criteria were: pregnancy, breast feeding, smoking, chronic non-steroid anti-inflammatory therapy, immunosuppression, scaling within the last 3 months.

The patients who qualified for the study were randomly divided (group number draw) into 2 groups:

- Group 1 (study): 20 patients - scaling + periodontal pocket rinse 3% H₂O₂ + photodynamic therapy with FotoSan[®];
- Group 2 (control): 20 patients - scaling + periodontal pocket rinse 3% H₂O₂

Before scaling and after 14 days each patient had the following parameters measured:

- Plaque index (PI), expressed in %,
- Bleeding index (BOP), expressed in %,
- Depth of periodontal pockets (PD), expressed in mm.

Examination

Ultrasonic scaling was performed with mini Piezon[®] (EMS) device, while polishing was performed with Prophy[®] (W&H) contra-angle handpiece and Detartrine[®] (Septodont) polish.

The FotoSan[®] device emits light at 2000mW/cm² luminous intensity (LED). The kit includes photosensitizer (0,1 mg/ml concentration toluidine blue, collected from a vial, available in three viscosities) and disposable perio, endo and blunt tips.

The study group patients were administered toluidine blue solution into periodontal pockets, then in 6 points around the tooth (buccal mesial, central and distal and analogically, palatal/lingual mesial, central and distal) there was the FotoSan[®] energy application for 10 seconds each with a perio tip (movements along and perpendicular to the long axis of the tooth), then with a blunt tip through the gingiva for 10 seconds in the projection of periodontal pocket.

None of the patients indicated any adverse effects of PACT therapy.

A statistical analysis was performed utilizing Shapiro-Wilk test, also with non-parametric tests (Wilcoxon paired test for comparisons between visits within each group and Mann-Whitney test for comparisons of change magnitude between test groups.)

Parameter	Group	N	Visit 1					Visit 2					Change between V2 and V1					p12	p Study-Control		
			Ave- rage	SD	Med- ian	Q1	Q3	N	Ave- rage	SD	Med- ian	Q1	Q3	N	Ave- rage	SD	Med- ian			Q1	Q3
PD av. [mm]	Study	20	2,5	0,6	2,5	2,3	2,7	20	1,7	0,4	1,8	1,4	1,9	20	-0,8	0,5	-0,8	-1,0	-0,6	0,000	0,000
	Control	20	2,9	1,1	2,8	2,2	3,9	20	2,7	1,0	2,8	1,9	3,5	20	-0,2	0,3	-0,2	-0,4	0,0	0,008	
BOP [%]	Study	20	46,3	17,6	43,6	36,7	57,0	20	23,8	11,1	23,4	15,0	32,4	20	-22,5	11,2	-19,9	-29,8	-14,3	0,000	0,000
	Control	20	63,3	22,6	69,5	43,8	82,1	20	57,3	22,5	60,4	38,2	73,4	20	-5,9	7,8	-5,1	-7,4	-1,7	0,001	
PI [%]	Study	20	57,8	25,7	57,3	40,6	80,0	20	41,9	18,0	47,2	30,0	56,9	20	-16,0	17,4	-11,6	-18,3	-6,1	0,000	0,148
	Control	20	71,1	15,5	74,2	63,1	81,2	20	63,6	15,2	63,3	57,1	72,5	20	-7,4	8,0	-10,0	-11,6	-2,6	0,002	

Table1. Study results - descriptive statistics within each study group at each visit and for change of studied parameters between visits

Results

The results were collectively shown in graphs (graph 1, 2, 3) and a table (Table 1).

Average pocket depth (PD av.) before treatment was 2.5 mm \pm 0.6 mm in the study group and 2.9 mm \pm 1.2 mm in the control group. After 14 days the results were respectively 1.7 mm \pm 0.4 mm and 2.7 mm \pm 1.0 mm. Changes of average PD within groups and differences between them were statistically significant. The BOP index had the following values in the study group: day 0 = 46.3% \pm 17.6, day 14 = 23.8% \pm 11.1. In the control group the values were respectively 63.3% \pm 22.6 and 57.3% \pm 22.5. Again changes within groups and differences between them were statistically significant.

Changes of plaque index (PI) values between groups were not statistically significant and were as follows: the study group: day 0 - 57.8%, day 14 - 41.9%; the control group: day 0 - 71.1%, day 14 - 63.6%.

The above results indicate the effectiveness of applied photodynamic therapy and confirm that its use in treatment of chronic periodontitis is justified.

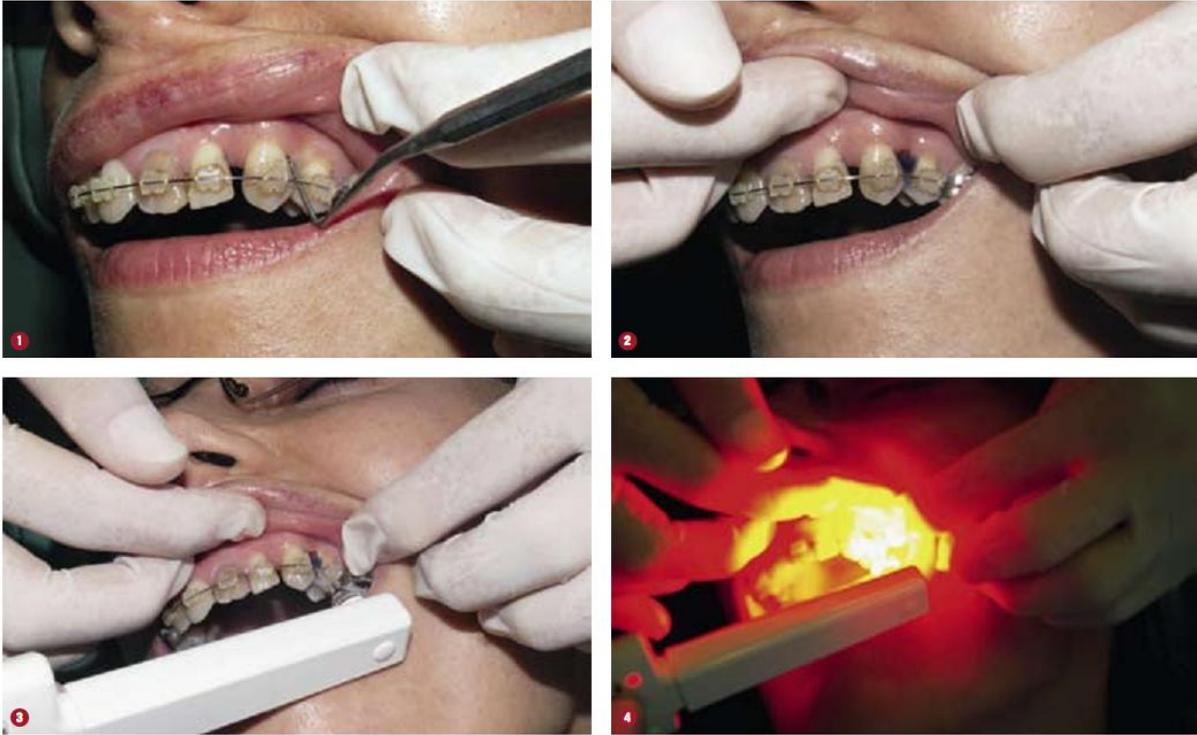


Fig. 1. Periodontal examination of a patient. Fig. 2. Condition after administration of photosensitizer (0,1 mg/ml solution of toluidine blue) into periodontal pocket. Fig. 3. Insertion of perio tip into the pocket. Fig. 4. Exposure of photosensitizer.

Discussion

The number of clinical studies involving photodynamic therapy in patients with chronic periodontitis is small. They show great methodological diversity, which hinders their comparison and usefulness as reference for own work.

Brown *et al.* (2008) assessed the efficacy of additional photodynamic therapy in patients with chronic periodontitis in relation to traditional SRP. Better clinical results were observed in the group treated with PACT within the following parameters: bleeding on probing (BOP), pocket depth (PD), clinical attachment level (CAL), amount of gingival crevicular fluid (9).

Another study was presented by Andersen *et al.* (2007), in which patients were divided into 3 groups. In Group I only photodynamic therapy was applied, in Group II - scaling and root planing, in Group III - both methods. Significantly better effects of treatment were observed in patients in Group III compared to Groups II and III (BOP, PD, CAL were assessed). The presented study confirms the results obtained by the above mentioned researchers (10).

Chondros *et al.* (2009) studied the efficacy of photodynamic therapy as a supplement to SRP in patients in maintenance phase, confirming the

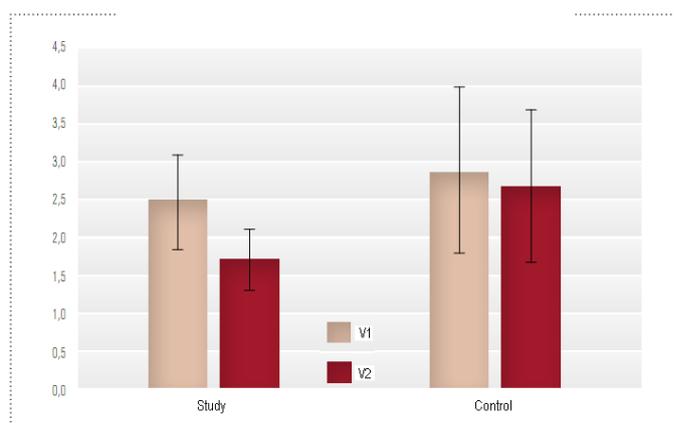
efficacy of PACT for reduction of bleeding. No statistically significant improvement in clinical attachment level and no reduction of pocket depth were observed (11). Contrary to the results of the above mentioned study, the own work showed not only a statistically significant reduction of bleeding index, but also a statistically significant reduction of periodontal pocket depths.

The results achieved by the authors of this study prove a high efficacy of photodynamic therapy with FotoSan[®] device in improvement of clinical condition in patients with chronic periodontitis. A significant reduction of bleeding index within the study group is particularly interesting. Patients subjected to photodynamic therapy have been under further observation (some of them for a few months) and their clinical picture is more promising than in traditionally treated cases.

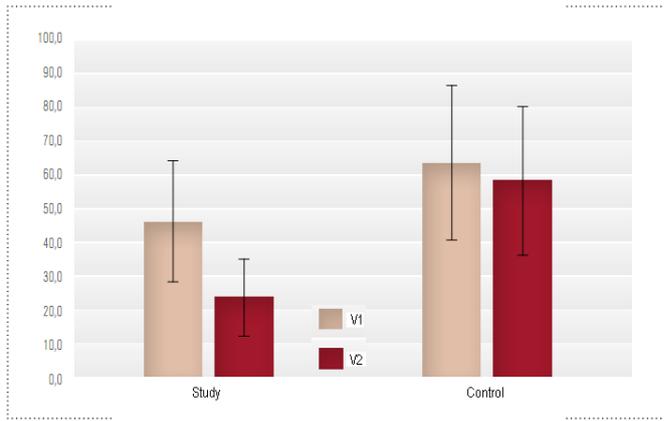
Conclusions

1. Photodynamic therapy with FotoSan[®] system fulfills expectations as an auxiliary source for improvement of clinical condition in patients treated for chronic periodontitis.
2. The therapy is safe for the patient and the GDP.
3. Due to low cost of therapy with FotoSan[®] system and a possibility to apply photodynamic therapy for the purpose of improving treatment results in periodontology, endodontics, implantology and dental surgery (reduction of indications for antibiotic therapy), it seems to be an interesting proposition for clinicians.

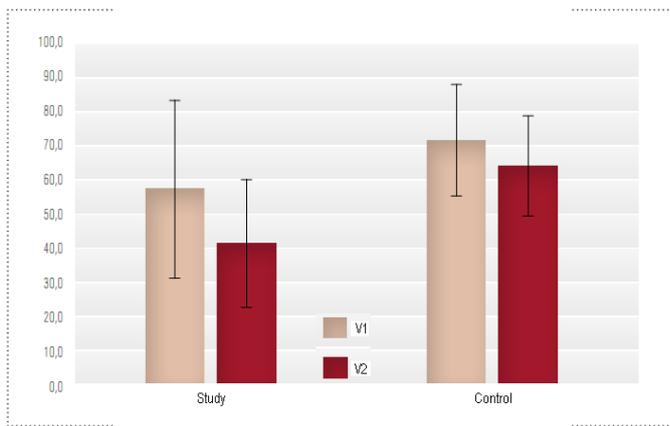
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Graph 1. PD av.



Graph 2 BOP



Graph 3. PI [%] - percentage index of dental plaque in both groups before and after treatment