DIAGNÓSTICO E TRATAMENTO DE DOENÇAS PERIODONTAIS INFLAMATÓRIAS

DIAGNOSIS AND TREATMENT OF INFLAMMATORY PERIODONTAL DISEASES

ДИАГНОСТИКА И ЛЕЧЕНИЕ ВОСПАЛИТЕЛЬНЫХ ЗАБОЛЕВАНИЙ ПАРОДОНТА

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Received 13 September 2019; received in revised form 22 January 2020; accepted 11 March 2020

RESUMO

O diagnóstico prematuro da cavidade oral leva a uma inflamação periodontal subjacente. Portanto, foi levantada uma questão de correção psicológica em pacientes com doenças periodontais inflamatórias, onde foi observado o papel do estado mental e a importância da adição desse componente terapêutico a um programa abrangente para o tratamento de pacientes em clínicas odontológicas. O estudo consistiu em duas etapas: diagnóstica e terapêutica. O primeiro estágio incluiu 76 pacientes que precisavam de um exame para detectar inflamação periodontal; esses pacientes foram examinados usando o dispositivo terapêutico e diagnóstico Fluorit-4S (TDD). A segunda etapa do estudo incluiu 28 pacientes com doenças periodontais inflamatórias. Os pacientes do grupo de estudo (14 pessoas) receberam tratamento usando um método de modulação mesodiencefalo (terapia MDM). Foi comprovada a possibilidade de detecção precoce de inflamação periodontal (mesmo no nível de um processo "latente") usando o dispositivo Fluorit-4S. Maior eficácia terapêutica do tratamento odontológico abrangente em pacientes com inflamação periodontal usando a terapia com Fluorit-4S TDD e MDM foi comprovada em comparação com a estratégia terapêutica padrão em termos de redução mais evidente no desconforto local (em 0,5 pontos em comparação ao grupo controle), diminuição significativa no índice de PMA (um índice que mede a presença ou ausência de inflamação gengival como ocorre nas papilas ou nas gengivas marginais ou anexadas) (em 0,9% em relação ao grupo controle), eliminação mais completa do foco patológico, bem como como uma completa normalização do estado emocional. O uso do Fluorit-4S TDD na prática odontológica permite ao dentista estudar mais de perto os tecidos afetados, resultando em conclusões objetivas sobre os processos patológicos na mucosa oral e, conseqüentemente, na seleção de estratégias terapêuticas adequadas para casos clínicos individuais.

Palavras-chave: *fluorite-4C, modulação de mesodiencefala, espectro infravermelho, método de fisioterapia, área de suprimento sanguíneo.*

ABSTRACT

Untimely diagnosis of the oral cavity leads to an underlying periodontal inflammation. Therefore, it was raised an issue of psychological correction in patients with inflammatory periodontal diseases where it was observed the role of mental state and the importance of the addition of this therapeutic component to a comprehensive program for the treatment of patients in dental clinics is emphasized. The study consisted of two stages: diagnostic and therapeutic. The first stage included 76 patients who needed an examination to detect periodontal inflammation; these patients were examined using the Fluorit-4S therapeutic and diagnostic device (TDD). The second stage of the study included 28 patients with inflammatory periodontal diseases. Patients of the study group (14 people) received treatment using a mesodiencephalic modulation method (MDM-therapy). It was proved the possibility of earlier detection of periodontal inflammation (even at the level of a "latent" process) using the Fluorit-4S device. Higher therapeutic efficacy of comprehensive dental treatment in patients with periodontal inflammation using the Fluorit-4S TDD and MDM-therapy was proved compared to standard therapeutic strategy in terms of more evident reduction in local discomfort (by 0.5 points compared to the control group), more significant decrease in the PMA index (an index that measures the presence or absence of gingival inflammation as occurring on the papillae or the marginal or attached gingivae) (by 0.9% compared to the control group), fuller elimination of the pathological focus, as well as a complete normalization of the emotional state. The use of the Fluorit-4S TDD in dental practice allows dentists to study the affected tissues more closely, resulting in objective conclusions on the pathological processes in the oral mucosa and, accordingly, the selection of adequate therapeutic strategies for individual clinical cases.

Keywords: *fluorit-4S, Mesodiencephalic modulation, Infrared spectrum, Physiotherapeutic method, Area of blood filling.*

АННОТАЦИЯ

Несвоевременная диагностика ротовой полости у пациентов приводит к скрытому воспалению пародонта. Поэтому авторами поднимается вопрос о необходимости психокоррекции пациентов с воспалительными заболеваниями пародонта; отмечена роль психологического состояния у таких пациентов; подчеркивается важность добавления данного компонента лечения в комплексную программу терапии пациентов стоматологических клиник. Проведенное исследование состояло из двух этапов: диагностического и терапевтического. Первый этап включал 76 пациентов, нуждающихся в обследовании для выявления воспаления пародонта, эти пациенты были обследованы с применением лечебно-диагностического комплекса «Флюорит-4С». Второй этап исследования включал 28 пациентов с воспалительными заболеваниями пародонта. Пациенты основной группы (14 человек) получали лечение с помощью метода мезодиэнцефальной модуляции (МДМ-терапии). Авторами доказана возможность более раннего выявления воспаления пародонта (еще на уровне «скрытого» процесса) с помощью комплекса «Флюорит-4С». Доказана более выраженная терапевтическая эффективность комплексного стоматологического лечения у пациентов с воспалением пародонта с помощью комплекса ЛДК «Флюорит-4С» и МДМ-терапии по сравнению со стандартными терапевтическими тактиками в виде более выраженного нивелирования местного дискомфорта (на 0,5 баллов по сравнению с группой сравнения), более выраженного снижения индекса РМА (на 0,9% по сравнению с группой сравнения), более полного устранения патологического очага, а также полной нормализации эмоционального состояния.

Ключевые слова: *флюорит-4С, мезодиэнцефальная модуляция, инфракрасный спектр, физиотерапевтический метод, область кровенаполнения.*

1. INTRODUCTION

In dental practice, periodontal inflammation is one of the most common pathologies. Inflammatory diseases of the tissues which surround the tooth can occur as independent pathologies or as a consequence of reconstructive interventions, for example, dental implantation. The presence of an inflammatory process in the periodontal tissues can lead to local and general discomfort in the form of local pain syndrome and associated impairment of masticatory function, general hyperthermia, impaired psychological state and quality of life, etc. Therefore, timely diagnosis and early therapy of this category of diseases is an integral part of comprehensive dental care (Danilevsky and Borisenko, 2000; Utyuzh *et al.*, 2016a; Utyuzh *et al.*, 2016b; Hajishengallis and Lamont, 2012; Holt and Ebersole, 2005; Grant, 2012; Garaicoa-Pazmino *et al.*, 2019; Marinho *et al.*, 2015; Campbell *et al.*, 2016; Hamilton *et al.*, 2016;). The quality of life of patients who have lost their teeth is significantly reduced. Loss of teeth causes psychological trauma, leads to pronounced aesthetic changes, diseases and exacerbations of the temporomandibular joint and gastrointestinal tract occur.

At present, the detection of patients with inflammatory processes in periodontal tissues at

the early stages of this pathology remains relatively low. This is due to many factors including:

- Psychological unpreparedness of patients to seek dental care at the early stages of the disease. Most often, patients find dental care in cases of severe clinical manifestations of the disease, when they feel a pronounced discomfort, leading to a decrease in the quality of life and psychological well-being. This is often associated with a widespread dentophobia among people which results in a delay in seeking medical advice after the first, still minor, symptoms of the disease (Brogardh-Roth *et al.*, 2017; Kinane *et al.*, 2017; Li *et al.*, 2019; Divaris, 2019; Hiyari *et al.*, 2018; Nibali *et al.*, 2019; Bergan *et al.*, 2014; Bebeko *et al.*, 2015; Moura *et al.*, 2015; Baek *et al.*, 2017; Subramaniam *et al.*, 2016; Wang *et al.*, 2016; Sankaranarayanan *et al.*, 2019; Jeong and Chang, 2015; Chang *et al.*, 2019):

- the absence of clinical manifestations or non-invasive methods for the detection of latent inflammation do not always allow diagnosis of this inflammation during preventive examinations (Tsepov *et al.*, 2008; Gupta *et al.*, 2018; Jepsen and Jepsen, 2016; Iviglia *et al.*, 2019; Echeverría *et al.*, 2019; Trombelli *et al.*, 2015; Page *et al.*, 2014).

The above shows the need to involve new diagnostic methods in the diagnosis of latent inflammations. One of the main principles of the

treatment of inflammatory periodontal diseases is an individual approach to the selection and planning of medical procedures.

The problem of treating patients with periodontal inflammations is complex. A dentist should pay attention both to the condition of the tissues in the mouth and to the psychological state of the patient, which, in patients with periodontal inflammations, often requires correction. Impaired psychological state may be a consequence of dental pathology or, on the contrary, one of the indirect etiopathological components of the inflammation in the mouth (Danilevsky and Borisenko, 2000; Brogardh-Roth *et al.*, 2017; Graziani *et al.*, 2010; D'Aiuto *et al.*, 2004;). Comprehensive treatment involves not only planning but also the mandatory provision of all necessary types of assistance. In this case, it is essential to correctly determine the sequence of measures needed to eliminate the disease and correctly make a forecast for each tooth. However, the involvement of psychologists or psychiatrists in the treatment of patients with dental diseases is not a routine practice in the dental clinic.

Inflammation of periodontal tissues can be observed in the infrared (IR) spectrum. Therefore, according to the authors, the Fluorit-4S therapeutic and diagnostic device (Fluorit-4S TDD) developed in the Scientific and Research Center of Biometric Devices of the Bauman Moscow State Technical University (SRCBD of the BMSTU) can be used to diagnose latent inflammation. Fluorit-4S TDD is intended for infrared diaphanoscopy of biological tissues. It can be used to visualize soft and hard tissues of the oral cavity in the near-infrared spectrum. The principle of action of the device is based on filtration of transmitted or reflected radiation from the examined tissues. Infrared rays can penetrate tissues 3–4 mm deep. Absorbed by the tissues, the energy quantum of infrared radiation is transformed into thermal energy, causing hyperemia. In this case, the main radiation-receiving environment is water contained in the tissues. Due to the increased content of infiltrate in the inflamed tissues, the affected tissues absorb infrared radiation to a greater extent (Zimnyakov, 2007; Kolpakov *et al.*, 2013).

During the development of the inflammatory process in the soft tissues, a region of hyperemia is formed, which is an area of high blood filling due to the expansion of blood vessels, and is characterized by an increased concentration of oxyhemoglobin, hemoglobin, and water, which in turn causes an increase in the absorption coefficient of the inflamed area

(Zimnyakov, 2007; Kolpakov *et al.*, 2013; Ben Amara *et al.*, 2018; Kolenbrander and London, 2013; Boutin *et al.*, 2017; Liu *et al.*, 2018;).

Infrared radiation has demonstrated its efficacy in the treatment of chronic and subacute inflammatory processes in various tissues, resolution of infiltrates after operations and trauma, chronic arthritis, arthrosioarthritis of the temporomandibular joint, chronic neuritis, neuralgia, myositis, Setton's stomatitis, trophic, hypogranulating decubitus mouth ulcers, etc. (Kolpakov *et al.*, 2013; Danilevsky *et al.*, 2001). This is due both to the ability of infrared radiation to improve local blood flow, indirectly affecting the regeneration processes in the periodontal tissues and to the photobiostimulation effects of the infrared radiation on the irradiated tissue (Prokhorova *et al.*, 2007; Al-Hebshi *et al.*, 2015; Belstrøm *et al.*, 2016; Caton *et al.*, 2018; Tonetti *et al.*, 2018).

In the diagnostic mode, the radiated wavelength is 0.83–0.9 μm , at a power of 3 mW. The therapeutic effect is achieved with pulse modulation at a frequency of 1–3 kHz; the wavelength is 0.89 μm , and the power is 6 mW (Zimnyakov, 2007; Kolpakov *et al.*, 2013). Therefore, we believe that the Fluorit-4S TDD, the action of which is based on infrared radiation, can be used both for diagnosis and treatment of latent periodontal inflammation.

The issue of correction of the patient's psychological state as part of comprehensive dental care in a dental clinic, in our opinion, can be resolved using physiotherapy methods. We propose to use mesodiencephalic modulation (MDM therapy), a method of physiotherapy based on the targeted action of various pulse currents with a frequency of 10,000 Hz, modulated in the low-frequency range from 20 to 100 Hz, on the subcortical-stem structures of the brain, which leads to the activation and normalization of a number of anti-stress systems of the body and results in normalization of the patient's psycho-emotional state (Karev *et al.*, 2002; Lacigova *et al.*, 2013).

Therefore, this study aimed to seek different ways of psychological correction in patients with dental diseases using the methods available to the dentist as part of comprehensive dental care.

2. MATERIALS AND METHODS

The study was carried out at the Department of Orthopedic Dentistry of the I.M.

Sechenov First Moscow State Medical University, in compliance with the principles of bioethics and deontology, after obtaining informed consent, and consisted of two stages: diagnostic and therapeutic.

At the first stage, 76 patients were examined using the Fluorit-4S TDD (Figure 1). This stage was carried out to establish the diagnostic effectiveness of the Fluorit-4S TDD (Table 1). At this stage, a repeated dental examination of patients was carried out using two methods: clinical and instrumental, using the Fluorit-4S TDD, with two weeks between. The second stage of the study was devoted to the establishment of the therapeutic efficacy of the Fluorit-4S TDD and MDM-therapy as part of comprehensive dental care in patients with periodontal inflammation. For this stage of the study, 28 patients with inflammatory periodontal diseases of various severity, pathological changes in which were detected using the Fluorit-4S TDD at the first stage of the research, were selected.

For a comparative analysis of the efficacy of the Fluorit-4S TDD and MDM-therapy in the treatment of periodontal diseases, the patients selected for the second stage of the study were divided into two groups of 14 people each. The study group (SG) included 14 patients who received therapy using the Fluorit-4S TDD and MDM-therapy. The mean age in the group was 31.4 ± 2.0 years. The course of treatment included 15 sessions of MDM-therapy and infrared radiation therapy using the Fluorit-4S TDD. The sessions using the Fluorit-4S TDD were carried out in the form of a 3-minute irradiation of the affected segment. The meetings of MDM-therapy lasted 30 minutes and were carried out immediately after the sessions using the Fluorit-4S TDD. The course duration was six weeks. The control group (CG) included 14 patients who received standard conservative treatment without the Fluorit-4S TDD and MDM-therapy. The mean age in the group was 32.1 ± 1.8 years. Patients of both groups underwent standard professional oral hygiene procedures before the significant treatment.

The evaluation of the effectiveness of treatment was based on the four following studies:

- subjective assessment (using a five-point scale, where 1 point - no discomfort, 5 points - significant discomfort);
- determination of the papillary-marginal-alveolar index (PMA index);
- infrared diaphanoscopy;

- psychodiagnostic examination using the following psychodiagnostic techniques: Beck Depression Inventory (BDI, A.T. Beck, 1961) – to identify depressive episodes in patients with periodontal inflammation; Beck Anxiety Inventory (BAI, A.T. Beck, 1961) – to identify the presence and severity of anxiety in patients with periodontal inflammation.

Statistical processing of data was carried out using methods of clinical and mathematical statistics (including determination of standard deviation and standard error of the mean, the Fisher exact test, the Student's t-test, and the universal value of the statistical probability – p). Parameters at $p < 0.05$ were considered statistically significant differences.

All procedures performed in studies involving human participants were following the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. A study was conducted under the requirements of the ethics committee (Protocol of the meeting of the ethics committee of the Moscow State Medical University No. 110-2019). Informed consent was obtained from all individual participants included in the study (Consent for the publication of clinical data).

3. RESULTS AND DISCUSSION:

During a routine clinical dental examination, periodontal inflammation was diagnosed in 38 patients of all subjects (76 patients). Diagnostic analysis of the mucous membranes of the oral cavity of all patients (76 patients) using the Fluorit-4S TDD showed pathological inflammatory processes, clearly visualized in the infrared spectrum, in the same 38 patients whose inflammation was detected during a routine examination (Table 2).

In 4 other patients (in whom clinical, including visual, manifestations of the inflammatory process were not diagnosed during routine examination), the presence of latent inflammations was found in the infrared spectrum using Fluorit-4S TDD (Figure 2).

Two weeks after the initial examination, the patients were re-examined. A repeated analysis showed the presence of active inflammation in the previously identified four patients who had no clinical manifestations of inflammation in the infrared spectrum during the first examination but latent inflammations were diagnosed using the Fluorit-4S TDD. The remaining 34 patients, who had no signs of inflammation in the infrared

spectrum during the first examination, according to the Fluorit-4S TDD data, were also considered healthy during the second examination. Therefore, our study demonstrated high efficacy of the Fluorit-4S TDD in the detection of "latent" inflammatory processes in the absence of false positive and false negative results (Table 2).

3.1. Study of the therapeutic efficacy of the Fluorit-4S TDD

The study showed a significant improvement in the periodontal condition in the SG compared to the initial; these results were significantly superior compared to the results in the CG. Subjective assessment of the local state of the oral mucosa. In the SG, after the treatment using the Fluorit-4S TDD, a significant subjective improvement in the periodontal condition in the form of reduced discomfort in the oral cavity was diagnosed (from 3.9 ± 0.2 points of discomfort severity to 1.0 ± 0.1 points), which was significantly higher than these parameters in the CG (where discomfort severity changed from 3.9 ± 0.2 points to 1.5 ± 0.2 points) ($p < 0.05$). The difference in the decrease in the severity of local discomfort between the SG and the CG was 0.5 points ($t_{\text{Emp}} = 2.7$) (Table 3).

Objective evaluation using the PMA index. In the SG, the mean PMA index before treatment was $59.2 \pm 1.1\%$; after the end of treatment using the Fluorit-4S TDD, this parameter was $7.3 \pm 1.5\%$ (the difference between the measurements was -51.9%), which was positively different from the CG ($p < 0.01$). In the CG, the initial mean PMA index was $60.5 \pm 1.2\%$ and at the end of the study, it was $9.1 \pm 1.4\%$ (the difference between the measurements was -51.0%). Therefore, the decrease in the PMA index in the SG by 0.9% was superior to the CG parameters.

Objective evaluation using infrared diaphanoscopy. IR-diaphanoscopy confirmed complete recovery (complete elimination of inflammation) in the SG in 93% of cases (13 people); in the CG, in 43% of cases (6 patients) signs of inflammation persisted, in 57% of cases (8 patients) there was complete recovery, which showed significant differences between the groups ($\phi^*_{\text{emp}} = 2.352$, $p < 0.01$). Therefore, our study demonstrated the high therapeutic efficacy of the Fluorit-4S TDD compared to standard conservative treatment only; subjective and objective examinations confirmed this.

3.2 Study of the therapeutic efficacy of MDM-therapy

The study of the emotional state of patients showed a significantly superior therapeutic effect in the sg compared to the cg. Examination of the level of depression in patients of both groups the depression level, according to the bdi test, did not significantly differ and corresponded to subdepression (14.75 ± 0.45 points in the sg, 14.74 ± 0.68 points in the cg) before the MDM-therapy. Upon completion of MDM-therapy, in all patients in the sg, depressive manifestations resolved (the mean score in the group was 3.22 ± 0.25 points), which significantly differed from the cg, wherein 86% of cases (12 patients) a subdepressive condition persisted (mean score 11.63 ± 0.78).

Study of the level of anxiety according to the bai test, a high level of anxiety was observed in patients of both groups (50.21 ± 0.62 points in the sg, 49.85 ± 0.54 points in the cg) before the beginning of therapy. After the completion of treatment, anxiety resolved in all patients in the sg (mean score in the group was 8.52 ± 0.35 points), whereas in the cg anxiety persisted at the moderate level (24.12 ± 0.42 points), which significantly differed from the cg ($p < 0.01$). Therefore, our study confirms the high therapeutic efficacy of MDM-therapy in the normalization of the emotional state in patients with inflammatory periodontal diseases.

4. CONCLUSIONS:

The study demonstrated the high diagnostic efficacy of the Fluorit-4S TDD in the detection of both active and latent inflammations of periodontal tissues. In 100% of cases, the Fluorit-4S TDD confirmed clinically detected pathologies, as well as diagnosed a pathological process that did not have clinical manifestations. There were no false positive and false negative results of examinations using the Fluorit-4S TDD.

The use of the Fluorit-4S TDD in dental practice allows dentists to study the affected tissues more closely, resulting in objective conclusions on the pathological processes in the oral mucosa and, accordingly, the selection of adequate therapeutic strategies for individual clinical cases. The Fluorit-4S TDD can be recommended for non-invasive diagnosis of inflammatory periodontal diseases, including early stages of the disease without its clinical manifestations, which will ensure timely treatment and minimize complications of the disease.

The high therapeutic efficacy of the Fluorit-4S TDD was established, which supported the use of this system by dentists both as a diagnostic tool

and as a method of physiotherapeutic therapy. In patients treated using the Fluorit-4S TDD, compared to patients who received conservative treatment only, local discomfort was significantly reduced (by 0.5 points), the PMA index was significantly decreased (by 0.9%), and the pathological focus was eliminated, which was confirmed by the infrared diaphanoscopy data.

Significantly higher positive results in patients whose therapeutic strategies included the Fluorit-4S TDD show that the Fluorit-4S TDD can be used as an alternative to a conservative pharmacotherapeutic method in cases when patients have contraindications or allergy history, as well as an additional therapy to guarantee improved treatment outcomes.

The evident therapeutic influence of MDM-therapy on the stabilization of the emotional state of patients with inflammatory periodontal diseases was proved. In patients who received MDM-therapy, a complete recovery of anxiety and depressive symptoms was observed, compared to the control group, which allows the recommendation of this physiotherapeutic method for use in dentistry as part of the comprehensive therapy of patients with inflammatory periodontal diseases.

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Table 1. Fluorit-4S TDD specification

Characteristic	Index
Range of vision	16*12 mm
Wavelength	890 nm
Power consumption	60 W
Control and power unit	
Size	320*120*245 mm
Weight	2 kg

Table 2. Diagnostic ability of a routine method of examination and the Fluorit-4S TDD

Examination / Result	Study population (n=76)			
	Clinically diagnosed periodontal inflammatory diseases		Periodontal inflammatory diseases diagnosed using the Fluorit-4S TDD	
	patients	%	patients	%
Primary examination	38	50.0	42	55.26
False positive results	–	–	–	–
False negative results	4	5.26	–	–

Table 3. Parameters of subjective assessment of local discomfort

Stage of the study	Study groups		t	p
	SG (n=15)	CG (n=15)		
	M±m	M±m		
Before treatment	3.9±0.2	3.9±0.2	0.3	>0.05
After treatment	1.0±0.1	1.5±0.2	2.7	<0.05
t	15.7	9.6		
p	<0.01	<0.01

Figure 1. Fluorit-4S therapeutic and diagnostic device (TDD)

Figure 2. Image obtained using the Fluorit-4S TDD, showing the inflammation of the gum near the tooth 1.1 (left) in the infrared spectrum