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SPECTROCOLORIMETRIC ASSESSMENT OF THE DEGREE OF GINGIVAL INFLAMMATION IN PATIENTS WITH PERIIMPLANTITIS DURING THERAPEUTIC AND PREVENTIVE MEASURES

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Summary.

Peri-implantitis is a leading cause of dental implant failure, necessitating timely, non-invasive monitoring of inflammatory progression. Spectrocolorimetry, utilizing the Schiller-Pisarev test, provides a quantitative method for assessing gingival epithelium status in vivo; however, clinical data on its application for monitoring treatment dynamics remain limited.

***Aim of the study** – to evaluate the efficacy of a combined therapeutic and preventive regimen in patients with peri-implantitis using spectrocolorimetric assessment of gingival inflammation.*

***Material and methods.** A prospective study enrolled 67 patients aged 25-55 years. The control group (n = 28) received standard therapy, the intervention group (n = 39) received standard therapy supplemented with a complex of antioxidant, anti-inflammatory, and osteotropic agents, administered as a repeated course after six months. Gingival inflammation was quantified using the «Pulsar» spectrocolorimeter at wavelengths of 460 nm and 660 nm at baseline, six months, and one year. All participants provided informed consent. The study adhered to the principles of the World Medical Association's Declaration of Helsinki and was approved by the Bioethics Commission of the SE «ISMFS NAMS» (Protocol No. 1011, 14 April 2022). Statistically significant differences between normally distributed quantitative variables were assessed using Student's t-test, with significance set at $p < 0.01$.*

This work is part of the research project «Correction of osteogenesis impairments in the management and prevention of dental disease complications in wartime» (State Registration No. 0123U103247).

***Results.** After six months, the intervention group demonstrated an increase in the light reflection coefficient to 71% at 460 nm and 79% at 660 nm, compared to 59% and 74%, respectively, in the control group. After one year, these values reached 80% and 85% in the intervention group, nearly doubling from baseline and significantly exceeding outcomes with standard therapy alone. These findings indicate long-term preservation of epithelial barrier integrity and regression of chronic inflammation only following the multicomponent regimen.*

***Conclusion.** Spectrocolorimetry is a highly sensitive method for monitoring treatment efficacy in peri-implantitis. Adjunct use of the developed therapeutic and preventive complex with standard therapy significantly improves soft tissue regeneration and sustains an anti-inflammatory effect over one year.*

***Key words:** Peri-Implantitis; Spectrocolorimetry; Schiller-Pisarev Test; Adult Patients; Combined Modality Therapy.*

Introduction

Peri-implantitis is a destructive inflammatory condition affecting soft and hard tissues around dental implants. Of polymicrobial etiology, it leads to progressive supporting bone loss and is a frequent late complication of implant therapy [1-3]. Current evidence reports clinically significant manifestations in nearly one-fifth of patients with osseointegrated implants, substantially reducing long-term rehabilitation success and patient quality of life [1-3].

Conventional diagnosis relies on bleeding on probing, peri-implant pocket depth, and marginal bone level assessment. However, these invasive methods primarily reflect cumulative morphological change and exhibit limited sensitivity in detecting active inflammation, even when bleeding is present [4]. Consequently, non-invasive approaches enabling real-time quantitative assessment of local pathophysiological processes are needed. Optical spectroscopy is a promising tool for monitoring peri-implant tissue status by measuring hemodynamic and metabolic parameters associated with inflammation in vivo [4,5]. Specifically, spectral analysis in the visible and near-infrared ranges informatively assesses microcirculatory oxygenation and tissue edema, recognized as sensitive markers of gingival inflammation.

Beyond spectroscopic blood flow evaluation, spectrocolorimetric analysis based on vital iodine staining of the epithelium (the Schiller–Pisarev test) has been introduced in periodontology. This test selectively stains gingival areas rich in glycogen, which increases during inflammation [6]. Staining intensity is objectively quantified via spectrocolorimetry as the light reflection coefficient. High iodine absorption (low reflection) indicates significant inflammation, while reduced staining reflects restored epithelial barrier function and inflammatory resolution [6].

Given the rising challenge of antimicrobial resistance [7-9] and the constraints of monotherapeutic strategies, there is growing adoption of multicomponent therapeutic regimens that combine local and systemic agents with antioxidant, immunomodulatory, and antimicrobial properties [10-14]. Evidence confirms that incorporating antioxidants mitigates oxidative stress and improves clinical markers of inflammation [10,12], while probiotic supplementation is associated with reduced bleeding on probing and peri-implant pocket depth in treatment phases [11,13,15]. Nevertheless, clinical studies systematically evaluating spectrocolorimetric parameters of gingival inflammation following such combined therapies remain scarce, hindering the standardization of monitoring protocols [16,17].

Aim of the study was to perform a spectrocolorimetric assessment of inflammatory processes in the periodontal and peri-implant mucosa of patients with peri-implantitis

undergoing a combined therapeutic and preventive regimen.

Material and methods. A total of 67 patients aged 25-55 years with peri-implantitis and a medical history including periodontitis and atherosclerosis were enrolled in this prospective study.

Participants were allocated into two groups:

– Group 1 – a control group (n=28) receiving standard protocol-based therapy alone;

– Group 2 – an intervention group (n=39) receiving standard therapy supplemented with a combined therapeutic regimen.

Patients in the control group received standard protocol-based, while patients in the intervention group received standard therapy supplemented with a combined therapeutic regimen comprising antioxidant, anti-inflammatory, microbiocenosis-restoring, microcirculation-enhancing, and osteotropic agents. The combined regimen was repeated six months after initiation.

Gingival inflammation was assessed spectrocolorimetrically using the Schiller–Pisarev test, which quantifies glycogen-dependent staining intensity of the epithelium. Measurements were performed with a «Pulsar» spectrocolorimeter (adapted for dental use; Denga O. V., 2001), recording optical reflection coefficients at 460 nm and 660 nm.

Biophysical analyses were conducted in the Biophysics and Functional Diagnostics Sector of the Department of Epidemiology and Prevention of Major Dental Diseases, Pediatric Dentistry, and Orthodontics at the State Establishment «The Institute of Stomatology and Maxillo-facial Surgery of the National Academy of Medical Sciences of Ukraine» (SE «ISMFS NAMS»). The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Bioethics Commission of the SE «ISMFS NAMS» (Protocol No. 1011, 14 April 2022). All participants provided written informed consent.

Statistical analysis was performed using variation statistics in Microsoft Office Excel 2016. Data are presented as mean values. Differences between groups were assessed using Student's t-test, with $p < 0.01$ considered statistically significant [18].

Results and discussion

Spectrocolorimetric assessment of inflammatory processes in the gingiva of patients with peri-implantitis was performed using the Schiller-Pisarev test during preventive interventions.

Higher values of the light reflection coefficient (R) indicate reduced penetration of iodine solution into tissues: at 460 nm (short wavelength), this reflects restoration of epithelial barrier function, while at 660 nm (long wavelength), it indicates decreased glycogen accumulation and subsequent resolution of inflammation.

Table 1 presents mean light reflection coefficients (R) of the gingival mucosa after Schiller-Pisarev staining in patients with peri-implantitis over one year of follow-up.

Table 1

Light Reflection Coefficient of Gingival Mucosa After Staining with Schiller-Pisarev Solution in Patients with Peri-implantitis During Preventive Measures, %

Groups / Wavelength	Intervention Group n=39	Control Group n=28
Baseline		
460 nm	51	53
660 nm	63	66
After 6 Months		
460 nm	71	59
660 nm	79	74
After 1 Year		
460 nm	80	54
660 nm	85	69

At baseline, both groups showed comparable staining intensity: R values were 51% and 63% (intervention group) versus 53% and 66% (control group) at 460 nm and 660 nm, respectively, confirming similarly pronounced inflammatory states and impaired capillary-epithelial barrier function. After six months, following the implementation of the combined therapeutic and preventive complex, patients in the intervention group showed marked increase in R values to 71% (460 nm) and 79% (660 nm), indicating restored epithelial integrity, normalized microcirculation, and reduced glycogen synthesis – consistent with regression of chronic inflammation In contrast, the control group exhibited minimal improvement (59% at 460 nm; 74% at 660 nm), demonstrating the limited efficacy of standard therapy alone.

At the one-year follow-up the intervention group maintained progressive improvement, with R values reaching 80% (460 nm) and 85% (660 nm), representing increases of 29% and 22% from baseline, respectively. This stabilization of spectrocolorimetric parameters reflects sustained epithelial barrier function and resolution of inflammatory metabolic activity. The control group, where only basic therapy was used, showed no further improvement beyond six-month values (54% at 460 nm; 69% at 660 nm), indicating persistence of chronic inflammation.

Comparative analysis revealed that the multicomponent therapeutic regimen produced a nearly two-fold increase in light reflection coefficients across both spectral bands compared to baseline values. This demonstrates restored epithelial barrier function, reduced microvascular hyperemia, and suppressed glycogen-dependent metabolic activation. Spectrocolorimetric monitoring confirmed the

high clinical efficacy of the combined therapeutic and preventive complex and established its value as a sensitive method for tracking long-term regression of peri-implantitis.

Conclusions

1. Adjunct use of a multicomponent therapeutic complex with standard therapy yields a statistically significant increase in gingival light reflection coefficients, indicating normalized microcirculation and inflammatory resolution.

2. The control group receiving only standard therapy showed minimal improvement in spectrocolorimetric parameters, confirming the limited long-term anti-inflammatory efficacy of basic treatment alone.

3. Spectrocolorimetry provides an objective quantitative method for evaluating treatment efficacy and is recommended for routine clinical monitoring of peri-implantitis.

Prospects for further research. Further studies with extended follow-up periods are warranted to determine the long-term stability of the therapeutic outcomes achieved with the combined modality therapy.

Conflict of interest: The authors declare no conflicts of interest.

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СПЕКТРОКОЛОРИМЕТРИЧНА ОЦІНКА СТУПЕНЯ ЗАПАЛЕННЯ ЯСЕН У ПАЦІЄНТІВ З ПЕРИІМПЛАНТИТОМ В ПРОЦЕСІ ЛІКУВАЛЬНО-ПРОФІЛАКТИЧНИХ ЗАХОДІВ

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Резюме.

Періімплантит є однією з головних причин втрати дентальних імплантатів і потребує своєчасного неінвазивного моніторингу запального процесу. Спектроколориметрія на основі проби Шиллера-Писарєва дає змогу кількісно оцінити стан епітелію ясен in vivo, але клінічні дані щодо її застосування в динаміці лікування обмежені.

Мета дослідження – визначити ефективність лікувально-профілактичного комплексу у пацієнтів із періімплантитом за допомогою спектроколориметричної оцінки запалення ясен.

Матеріал і методи. У проспективне дослідження включено 67 пацієнтів віком 25–55 років. Група порівняння (n = 28) отримувала базову терапію, основна група (n = 39) – базову терапію + комплекс антиоксидантних, протизапальних та остеотропних препаратів (повторний курс через 6 місяців). Ступінь запалення оцінювали спектроколориметром «Пульсар» на довжинах хвиль 460 нм і 660 нм у вихідному стані, через 6 місяців і 1 рік. Всі пацієнти надали інформовану згоду на участь у дослідженні, яке здійснювалося з дотриманням принципів Етичного кодексу Всесвітньої медичної асоціації (Гельсінська декларація). Відповідно засідання Комісії з питань біоетики ДУ «ІСЩЛХ НАМН» (протокол № 1011 від 14.04.2022), було дозволено проведення цього дослідження. Статистично значущу відмінність між альтернативними кількісними ознаками з розподілом, відповідним нормальному закону, оцінювали за допомогою t-критерію Стьюдента. Різницю вважали статистично значущою при $p<0,01$. Дослідження є фрагментом науково-дослідної роботи «Корекція порушень процесів остеогенезу при лікуванні та профілактиці ускладнень стоматологічних захворювань у воєнний час», державна реєстрація № 0123U103247.

Результати. Вже через 6 місяців в основній групі коефіцієнт відбиття світла зріс до 71 % (460 нм) і 79 % (660 нм) проти 59% і 74% у групі порівняння. Через рік показники сягнули 80 % та 85 % відповідно, що майже удвічі перевищувало вихідний рівень та достовірно перевищувало результати базової терапії. Отримані дані свідчать про довготривале збереження бар'єрної функції епітелію та регрес хронічного запалення лише за умови застосування мультикомпонентної схеми.

Висновок. Спектроколориметрія є високочутливим методом контролю ефективності лікування періімплантиту. Додавання розробленого лікувально-профілактичного комплексу до базової терапії забезпечує значно кращу регенерацію м'яких тканин та стабільний протизапальний ефект протягом року спостереження.

Ключові слова: періімплантит; спектроколориметрія; проба Шиллера-Писарєва; дорослі пацієнти; лікувально-профілактичний комплекс.

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