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# CLINICAL USE OF LASER RADIATION IN THE TREATMENT OF GENERALISED PERIODONTITIS

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# КЛІНІЧНЕ ЗАСТОСУВАННЯ ЛАЗЕРНОГО ВИПРОМІНЮВАННЯ ПРИ ЛІКУВАННІ ГЕНЕРАЛІЗОВАНОГО ПАРОДОНТИТУ

INFORMATION

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ABSTRACT

Periodontal tissue diseases are inflammatory disorders linked to an imbalance of the oral microflora, with a predominance of periodontopathogenic microorganisms. Periodontitis causes the destruction of periodontal structures, gum bleeding, the formation of periodontal pockets and the loss of epithelial attachment. Conventional therapeutic approaches often fail to achieve stable results; therefore, the implementation of combined treatment methods, particularly those involving low-intensity light irradiation, remains highly relevant.

**The purpose of this research** was to evaluate the influence of low-level laser radiation on periodontal tissues and on clinical indices, including the papilla bleeding index and periodontal pocket depth, in patients diagnosed with chronic generalised periodontitis of grades I–II.

**The study** involved 50 patients with chronic generalised periodontitis of grades I–II. Participants were divided into two groups: group 1 (23 patients) received standard treatment, while group 2 (27 patients) received standard therapy supplemented with low-level laser radiation in the red range (wavelengths 660 nm). Each irradiation session lasted 10 minutes, with a total of 10 sessions per treatment course. Treatment outcomes were assessed using the PMA and hygiene indices, the papilla bleeding index, and measurements of periodontal pocket depth.

Improvement in all measured parameters was observed in both groups following treatment. However, group 2 demonstrated significantly better outcomes for periodontal condition indices and periodontal pocket depth compared with group 1. Six months after treatment, the PMA, hygiene, and papilla bleeding indices in group 2 were 30–62.2 % higher than those in group 1. The mean reduction in periodontal pocket depth in group 2 was 1.26 mm relative to baseline values, which was 20.7 % greater than the 0.72 mm reduction observed in group 1.

Laser radiation has a favourable impact on oral hygiene dynamics, clinical indices of periodontal condition, and the reduction of periodontal pocket depth. Due to its anti-inflammatory properties, low-level laser therapy may be recommended as an effective adjunct to conventional treatment in the comprehensive management of periodontal diseases.

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**Ключові слова:** лазерне випромінювання; низькоінтенсивне випромінювання; захворювання тканин пародонту; пародонтит; індексна оцінка тканин пародонту; пародонтальна кишеня; лікування пародонтиту.

АНОТАЦІЯ

Захворювання тканин пародонту є запальними станами, пов'язаними з порушенням балансу мікрофлори ротової порожнини, що характеризується переважанням пародонтопатогенних мікроорганізмів. Пародонтит призводить до руйнування структур тканин пародонта, виникнення кровоточивості ясен, утворення пародонтальних кишень і втрати епітеліального прикріплення. Традиційні методи терапії не завжди забезпечують стійкий клінічний ефект, тому впровадження комбінованих методів лікування, зокрема з використанням низькоінтенсивного лазерного випромінювання, є надзвичайно актуальним.
**Метою дослідження** було оцінити вплив низькоінтенсивного лазерного випромінювання на тканини пародонта й клінічну індексну оцінку, зокрема індекс кровоточивості ясенних сосочків і глибину пародонтальних кишень, у пацієнтів із хронічним генералізованим пародонтитом I–II ступенів.
У дослідження залучено 50 пацієнтів із хронічним генералізованим пародонтитом I–II ступенів. Пацієнтів поділено на дві групи: у групі 1 (23 особи) проводили загальноприйнятий протокол лікування, зі зняттям зубних відкладень, застосуванням протизапальної та антибактеріальної терапії, тоді як у групі 2 (27 осіб) загальноприйнятий протокол доповнювали застосуванням низькоінтенсивного лазерного випромінюванням червоного спектру (довжина хвилі 660 нм). Тривалість одного сеансу становила 10 хвилин, курс лікування – 10 процедур. Ефективність лікування оцінювали за показниками індексів РМА, індексу гігієни, індексу кровоточивості ясенних сосочків і глибиною пародонтальних кишень до лікування на 14-й день лікування, через 3 та через 6 місяців від початку лікування.
Після проведеного лікування покращення клінічних показників відзначалося в обох групах. Однак у пацієнтів 2 групи спостерігалися значно кращі результати за індексами стану пародонта та глибиною пародонтальних кишень порівняно з групою 1. Через 6 місяців після лікування показники РМА, індексу гігієни й індексу кровоточивості ясенних сосочків у 2 групі були на 30–62,2 % кращими, ніж у 1 групі. Середнє зменшення глибини пародонтальних кишень у пацієнтів 2 групи становило 1,26 мм порівняно з вихідними даними, що на 20,7 % перевищує показники хворих 1 групи, де зменшення становило 0,72 мм.
Низькоінтенсивне лазерне випромінювання позитивно впливає на динаміку індексної оцінки стану тканин пародонта та зменшення глибини пародонтальних кишень упродовж лікування пацієнтів з хронічним генералізованим пародонтитом. Завдяки своїм вираженим протизапальним властивостям низькоінтенсивна лазерна терапія може бути рекомендована як ефективний додатковий метод у комплексному лікуванні запальних і дистрофічних захворювань пародонта.

**Topicality.** Periodontal tissue diseases, including generalised periodontitis, are inflammatory conditions primarily caused by the presence of pathogenic microflora [1; 2]. Research shows that the onset of periodontal tissue diseases is associated with oral microbiota dysbiosis dominated by periodontopathogenic microorganisms and is dependent on unregulated inflammatory responses in the host [3; 4]. Periodontitis leads to the destruction of periodontal tissues, gum bleeding, formation of periodontal pockets and loss of epithelial attachment [5; 6].

The main treatment method for periodontitis currently remains the use of manual instruments (curettes) and ultrasonic scalers – Scaling and Root Planing (SRP). However, this method does not always achieve long-term desired outcomes, particularly due to the persistence of periodontopathogenic microflora in tissues [7; 8; 9], and the recolonisation of deep periodontal pockets by pathogenic microorganisms is a cause of periodontitis exacerbation [10; 11]. Therefore, the application of combined treatment methods for periodontal tissue diseases remains relevant, including the use of laser, LED, and polarised radiation, which have proven therapeutic effects and positively influence physiological processes in periodontal tissues [12; 13].

Experimental studies have shown that low-power radiation of specific parameters has a bactericidal effect on conditionally pathogenic microorganisms and a biostimulatory effect on host cells [14; 15]. Photobiomodulation (PBM) therapy is a useful adjunct in both surgical and non-surgical periodontal treatment. When combined with SRP, it helps reduce inflammation, accelerate tissue repair, and manage postoperative pain, edema, and dentin hypersensitivity, stimulates cell proliferation, angiogenesis, and osteoblast differentiation [16; 17]. PBM is especially beneficial in cases with systemic risk factors like smoking and can support healing in procedures involving soft and bone tissue regeneration [18]. Lasers used in PBM, operating within the visible to near-infrared range (630–980 nm), have demonstrated therapeutic potential in non-surgical periodontal therapy by mitigating gingival inflammation. This effect is associated with the downregulation of activated macrophage markers, suppression of reactive nitrogen species, and decreased expression of pro-inflammatory cytokines. Notably, lasers operating at a wavelength of 660–670 nm, when used adjunctively with conventional periodontal therapy, have been associated with improved clinical outcomes and reduced treatment duration [19].

Low-level laser therapy (LLLT) has shown clinical benefits across various oral conditions. It reduces inflammation, pain, and healing time in aphthous ulcers, herpes simplex infections, oral lichen planus, and mucositis. It also improves salivary flow in xerostomia and supports nerve recovery in paresthesia. In periodontitis, adjunctive use enhances healing and collagen formation. Its analgesic effects are linked to endorphin release and modulation of pain transmission, while lymphatic stimulation contributes to edema reduction [20].

In vivo investigations have confirmed that LLLT promotes osteoblast activity and neovascularization, while also accelerating the resorption of particles within the core of bone defects [21; 22]. Nevertheless, the precise mechanism underlying LLLT-induced bone regeneration remains uncertain – specifically, whether it stems from the activation of mesenchymal stem cells or the direct stimulation of osteoblasts [22]. Furthermore, inconsistent outcomes have been reported regarding LLLT's impact on bone healing, likely due to differences in irradiation parameters, experimental models, laser dosage, application protocols, defect dimensions, and the biomaterials employed [23].

Thus, **the aim of the study** was to determine the effect of low-level laser radiation on periodontal tissues and indicators of index assessment of periodontal tissue condition, papillary bleeding, and periodontal pocket depth in patients with chronic generalised periodontitis of stages I–II.

**Materials and Methods.** The study was conducted at the University dental clinic in Uzhhorod, involving 50 patients aged 35 to 59 years with chronic generalised periodontitis.

Each patient underwent a comprehensive clinical examination, including inspection of dental arches, condition of oral mucosa and gums, oral vestibule, regional lymph nodes, and radiological examination to assess the bone tissue of the alveolar process of the maxilla and mandible and determine the degree of bone resorption. Index assessment of periodontal tissues was performed using the PMA index by Parma (1960), hygiene index (Yu. A. Fedorov, V. V. Volodkina, 1971), papillary bleeding index (PBI, Saxer and Muhlemann, 1975), and periodontal pocket depth (PPD) measured with a WHO-recommended graduated periodontal probe. These indicators were assessed before treatment, on the 14th day of treatment, and at 3 and 6 months post-treatment.

Additionally, before and after treatment on day 14, all patients underwent sampling of microflora from periodontal pockets to determine their quantitative and qualitative composition and to perform antibiograms.

Patients were divided into two groups: group 1 included 23 patients with stage I–II chronic generalised periodontitis who received conventional treatment; group 2 included 27 patients with the same diagnosis who additionally underwent a course of low-level laser radiation in the red spectrum with wavelengths of 660 nm and with a power density of 50 mW/cm$^2$.

The source of laser radiation was the certified medical device "Medik-2K" (Fotonica Plus, Cherkasy, Ukraine).

Irradiation with the laser radiation in group 2 was performed by application at a distance of 50 cm from the mucosa of the affected gum area, with an exposure time of 10 minutes. The light power density of the "Medik-2K" device was 50 mW/cm$^2$, with the scanning figure "circle that converges to a point". After each procedure, "Metrogyl Denta" gel was applied to the irradiated gum area. The irradiation course consisted of 10 procedures each day.

Patients in both groups received conventional treatment according to the following protocol. Prior to treatment, professional oral hygiene was performed, including removal of dental deposits according to the Guided Biofilm Therapy (GBT) protocol using Air-flow Perio, removal of hard deposits with an ultrasonic scaler (Woodpecker, China), and manual removal using protocol Scaling and Root Planing (SRP). After hygiene procedures, all patients received oral hygiene instructions.

Pharmacological treatment included: non-steroidal anti-inflammatory drug "Flamidez", antibiotics based on antibiogram for 7 days, probiotics for 7 days, rinsing with 0.05 % chlorhexidine bigluconate solution for 5 days, application of Metrogyl Denta gel on gums for 14 days, and Ascorutin for 1 month.

Statistical data processing, including calculation of arithmetic mean and standard deviation, was performed using Statistica 10.0 software (StatSoft Inc., USA). Student's t-test was used to determine the significance of differences between treatment indicators in the patient groups. Differences were considered statistically significant at $p < 0.05$.

**Results and Discussion.** Comparing treatment outcomes in both patient groups, it was noted that significantly faster improvement in index assessment indicators, papillary bleeding, and periodontal pocket depth occurred in group 2, where laser radiation was additionally applied. Baseline indicators of periodontal tissue index assessment and pocket depth were comparable across both groups.

The results of periodontal tissue index assessment and pocket depth measurements for both groups are presented in Table 1.

The PMA index in group 1 on day 14 was 23.2 ± 3.86, at 3 months – 22.4 ± 3.40, and at 6 months – 24.5 ± 3.64, which is 45 % better compared to baseline – 44.6 ± 10.55 ($p < 0.0001$). In group 2, the PMA index on day 14 was 19.7 ± 2.79, at 3 months – 16.3 ± 1.92, and at 6 months – 13.4 ± 1.54, which is 72.2 % better compared to baseline – 48.2 ± 9.16 ($p < 0.0001$). Comparing the groups, PMA improved significantly faster in group 2: on day 14 it was 15 % better than group 1 ($p = 0.0005$), 27.2 % better at 3 months ($p < 0.0001$), and 45.3 % better at 6 months ($p < 0.0001$).

The hygiene index in group 1 on day 14 was 1.5 ± 0.44, at 3 months – 1.6 ± 0.39, and at 6 months – 1.8 ± 0.59, which is 35.7 % better than baseline – 2.8 ± 0.49. In group 2, the index was 1.41 ± 0.29 on day 14, 1.19 ± 0.09 at 3 months, and 1.26 ± 0.13 at 6 months, which is 56.4 % better than baseline – 2.89 ± 0.53. Comparing the groups, the index improved faster in group 2: 6 % better on day 14, 25.6 % better at 3 months, and 30 % better at 6 months.

PBI data during and after treatment indicate improvement in periodontal tissue condition in both groups. In group 1, PBI was 0.59 ± 0.45 on day 14, 0.64 ± 0.44 at 3 months, and 1.27 ± 0.63 at 6 months, which is 55.2 % better than baseline – 2.84 ± 0.57. In group 2, PBI was 0.45 ± 0.39 on day 14, 0.41 ± 0.36 at 3 months, and 0.48 ± 0.39 at 6 months, which is 83.5 % better than baseline – 2.92 ± 0.66. Comparing the groups, PBI improved significantly faster in group 2: 23.7 % better on day 14, 35.9 % better at 3 months, and 62.2 % better at 6 months.

Periodontal pocket depth (PPD) also decreased in patients of both groups after treatment. In group 1, on the 14th day of treatment, PPD was 3.32 ± 0.43, which is 0.48 mm less compared to the data before treatment – 3.8 ± 0.26, after 3 months – 3.19 ± 0.38, which is 0.61 mm less before treatment and after 6 months – 3.08 ± 0.32, which is 0.72 mm less, respectively (Table 1). In group 2, on the 14th day of treatment, PPD was 3.15 ± 0.44, which is 0.55 mm less compared to the data before

**Table 1**
Dynamics of periodontal tissue index scores and periodontal pocket depth in patients with chronic generalised periodontitis

| Treatment period | Patient groups | Indicators | | | |
|---|---|---|---|---|---|
| | | PMA index % | Hygiene index | Papilla bleeding index (PBI) | Periodontal pockets depth (PPD), mm |
| ***Before the treatment*** | Group 1 (*n* = 23) | 44.6 ± 10.55 | 2.8 ± 0.49 | 2.84 ± 0.57 | 3.8 ± 0.26 |
| | Group 2 (*n* = 27) | 48.2 ± 9.16 | 2.89 ± 0.53 | 2.92 ± 0.66 | 3.7 ± 0.45 |
| ***On the 14th day of treatment*** | Group 1 (*n* = 23) | 23.2 ± 3.86 | 1.5 ± 0.44 | 0.59 ± 0.45 | 3.32 ± 0.43 |
| | Group 2 (*n* = 27) | 19.7 ± 2.79 | 1.41 ± 0.29 | 0.45 ± 0.39 | 3.15 ± 0.44 |
| ***In 3 months*** | Group 1 (*n* = 23) | 22.4 ± 3.40 | 1.6 ± 0.39 | 0.64 ± 0.44 | 3.19 ± 0,38 |
| | Group 2 (*n* = 27) | 16.3 ± 1.92 | 1.19 ± 0.09 | 0.41 ± 0.36 | 2.75 ± 0.37 |
| ***In 6 months*** | Group 1 (*n* = 23) | 24.5 ± 3.64 | 1.8 ± 0.59 | 1.27 ± 0.63 | 3.08 ± 0.32 |
| | Group 2 (*n* = 27) | 13.4 ± 1.54 | 1.26 ± 0.13 | 0.48 ± 0.39 | 2.44 ± 0.34 |

treatment – 3.7 ± 0.45, after 3 months – 2.75 ± 0.37, which is 0.95 mm less than before treatment and after 6 months – 2.44 ± 0.34, which is 1.26 mm less, respectively (Table 1). Comparing the groups among themselves, on the 14th day of treatment, PPD in group 2 decreased by 5.12 % compared to group 1, after 3 months by 13.7 % and after 6 months by 20.7 %, respectively.

The results of this study show that the use of low-level laser radiation of red spectrum with 660 nm in the treatment of generalised periodontitis improves the index assessment of periodontal tissues, the PBI index, and PPD indicators, compared with the data of patients who did not undergo tissue irradiation. The better treatment results of patients in group 2 who underwent sessions of irradiation with low-level laser radiation of the red spectrum can be explained primarily by the biostimulating effect of low-intensity light on the tissues of the macroorganism, as well as by both a direct inhibitory effect on periodontal pathogenic microorganisms and a synergistic interaction with antibiotics, namely by increasing the sensitivity of irradiated microorganisms to antimicrobial agents [24].

**Conclusions.** The use of low-level laser radiation in combination with conventional treatment methods for patients with chronic generalised periodontitis significantly accelerates and improves the indicators and results of treatment in patients of group 2, who were additionally treated with a course of irradiation, compared with patients of group 1, who were treated only with the conventional treatment method. After 6 months, the results of the PMA, hygiene indices and the gingival papilla bleeding index of group 2 were 30–62.2 % better than those of group 1. The depth of periodontal pockets in patients of group 2 decreased on average by 1.26 mm, compared with the initial data before treatment, which is 20.7 % better than the indicators of group 1, where the reduction in the depth of periodontal pockets occurred by 0.72 mm. Thus, laser radiation has a positive effect on the dynamics of the index assessment of the condition of periodontal tissues and the depth of periodontal pockets, due to its anti-inflammatory effect on periodontal tissues and can be recommended for use in the complex treatment of periodontal tissue diseases.

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