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ABSTRACT

The possibility of using a multi-modal approach in the clinical practice of a dermatologist for psoriasis, which includes 3 optical non-invasive technologies: laser Doppler flowmetry, video capillaroscopy, and laser speckle-contrast imaging, is demonstrated. The dynamics of changes in the main microhemodynamic parameters of the microcirculatory bed of patients with psoriasis during conservative therapy was studied, and the effectiveness of treatment of patients suffering from psoriasis was evaluated.

Keywords: multimodal approach, laser Doppler flowmetry, video capillaroscopy, laser speckle-contrast imaging, microcirculatory disorders, psoriasis.

1. INTRODUCTION

According to statistics, psoriasis is one of the most common chronic, recurring dermatoses, found in 2-3% of the world's population. The most common form is plaque-like psoriasis, which occurs in 80-90% of all patients with psoriasis[1]. Pathological changes in psoriasis in most cases are associated with the blood microcirculation system and occur long before the clinical manifestations of the disease[2]. It was revealed that with psoriasis in the stationary stage, structural disorganization of the capillaries occurs, which is expressed in the tortuosity, expansion, extension and thickening of the capillaries[3-6]. In addition to structural changes in the microvasculature, there is an increase in cutaneous blood flow in the area of psoriatic lesions relative to intact tissue, which indicates an active flow of arterial blood into the capillary bed of the affected area[7]. The disease therapy currently used in clinical practice is mainly aimed at normalizing hemodynamic parameters. At the same time, an increase in the effectiveness of therapy and the achievement of a stable remission of psoriasis has been and remains at the moment an acute and not completely resolved problem in world and domestic dermatology[8-9]. All this determines the relevance of this study, aimed at assessing the effectiveness of therapy for patients with psoriasis, using a multimodal approach.

Monitoring the effectiveness of the therapy can be carried out by the integrated application of laser Doppler flowmetry (LDF), laser speckle-contrast imaging (LSCI) and video capillaroscopy (VCS). Such a multimodal approach allows one to obtain more complete diagnostic information about the regulatory mechanisms of microhemodynamics, the spatial distribution of blood flow, the functional and anatomical parameters of capillaries[10], and also to evaluate the effectiveness of the therapy with the possibility of its correction[11].

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2. MATERIAL AND METHODS

The study involved 6 patients (3 men and 3 women) aged 38 ± 16 years old diagnosed psoriasis vulgaris. All participants in the experimental studies were familiarized with the contents and methods of diagnosis and signed an informed voluntary consent form. Experimental studies were carried out in accordance with the protocol approved at a meeting of the ethics committee at the Orel State University named after I.S. Turgenev from 16.11.2018 (protocol №10). The study did not include patients with a history of an acute period of chronic diseases that could affect the end result of the study. All measurements were carried out in a room with a temperature of 23-24° in a sitting position, in conditions of physical and psychological rest, 2 hours after eating with a preliminary 15-minute adaptation. In order to assess the effectiveness of the applied treatment in a hospital, which averages 12-14 days, the study was conducted 3 times.

The introduction of a multimodal approach into the clinical practice of a dermatologist will allow to evaluate the effectiveness of the treatment and adjust it, depending on the individual characteristics of the body. Thus, this approach will personalize the treatment of patients with psoriasis.

The microcirculation index was recorded using an LDF channel of the LAKK-M multifunctional laser non-invasive diagnostic complex (NPP LAZMA, Russia) at a wavelength 1064 nm in the average diagnostic volume of 1-3 mm3 in the area of psoriatic lesion and in the area of uninvolved (intact) tissue, at a distance of 1-2 cm from the affected area. The duration of the measurement at each site was 10 minutes. To implement the LSCI method, an experimental setup was used to record the speckle picture of the studied area on a video camera. To capture images of capillaries for the subsequent assessment of their parameters (for example, density), the VCS setup was used. The total duration of one study averaged 30 minutes.

3. EXPERIMENTAL RESULTS AND DISCUSSION

Initially, microcirculation parameters were evaluated when patients were admitted to the hospital, before the start of therapy. So, according to the results of clinical studies obtained by the LDF method, it follows that high values of the indicator of blood microcirculation in the area of psoriatic lesion (Im psor = 14.1 ± 5.3 p.u.) relative to intact tissue (Im int = 6.8 ± 2.6 p.u.) indicate an increased flow of arterial blood into the capillary bed. Along with this, an increase in the values of cardiac oscillations in the psoriatic plaque (Ac psor = 0.8 ± 0.2 p.u.) compared with conditionally healthy skin (Ac int = 0.4 ± 0.2 p.u.), which also confirms the fact of an increase in blood flow from the arterial link as a result of the inflammatory process and ineffective blood outflow.

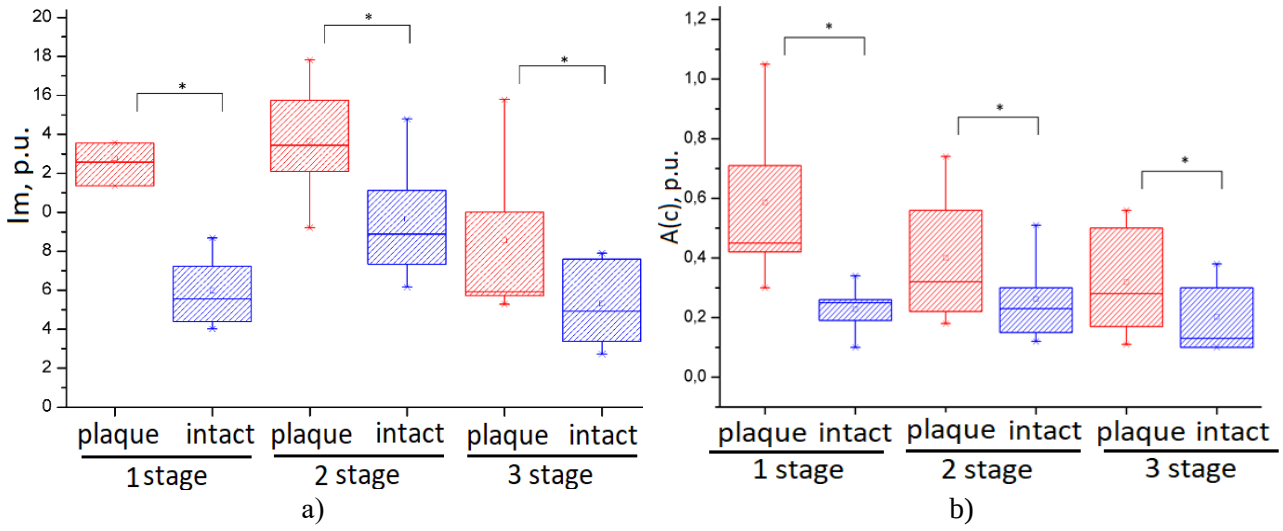

Figure 1 - Diagrams of the range of parameters for the microcirculation index (a) and pulse amplitude (b)

At the final stage of treatment, there was a decrease in the rate of blood microcirculation both in the area of psoriatic lesions (Im psor = 9.9 ± 5.9 p.u.) and in intact tissue (Im int = 6.3 ± 2.5 p.u.). In addition, there is a decrease in the amplitudes of the heart rhythm in the region of psoriatic plaque (Ac psor = 0.5 ± 0.1 p.u.) and in intact tissue (Ac int = 0.3 ± 0.2 p.u.), which indirectly indicates a positive effect of the applied therapy. Figure 1 presents the results of statistical data processing in the form of span diagrams for the microcirculation index (a) and the amplitude of pulse oscillations (b). Statistical significance of differences of values confirmed c $p < 0.05$ using one-way analysis of variance (One-way ANOVA).

When using the multimodal approach using two more methods (VCS and LSCI) and visualization of the studied area, the results obtained by the LDF method were confirmed, which more fully allows to evaluate the effect of the applied therapy.

Thus, using the VCS method, before the initiation of drug treatment in the area of psoriatic plaque, an increased number of capillaries was observed n = 90 capillaries in 1 mm2 (Fig. 2a) as compared with intact tissue n = 66 capillaries in 1 mm2 (Fig. 2d), which confirms the fact of an active influx of arterial blood into the capillary bed of the affected area.

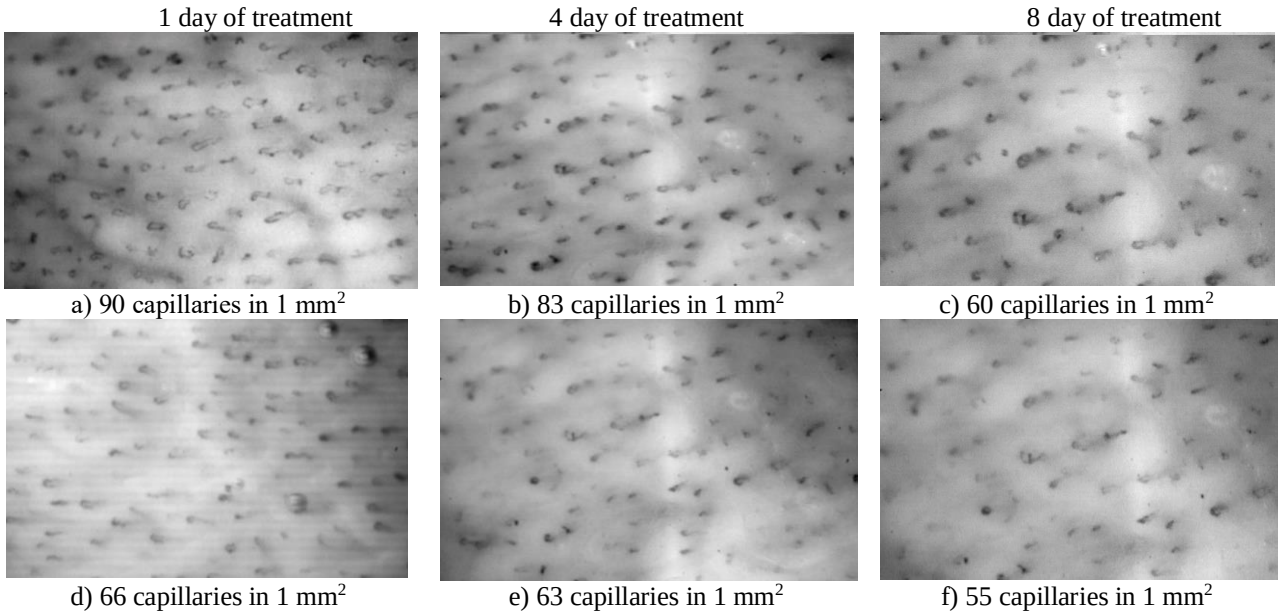

Figure 2 - Capillary network of patients in psoriatic plaque (a-c) and in the area of uninvolved skin (d-f)

At the final stage of treatment, there was a tendency toward a decrease in the number of visualized capillary loops per unit area both in psoriatic tissue n = 60 drops in 1 mm2 (Fig. 2c) and in intact tissue n = 55 drops in 1 mm2 (Fig. 2f) relative to previous stages of the study, which may indirectly indicate a decrease in the level of blood supply in the study area and indicate a decrease in the activity of inflammatory processes.

In addition, the speckle pattern at the initial stage of the study (before the start of therapy) has low values of average contrast in the lesion area relative to intact tissue, which indicates increased microcirculation in the lesion area (Fig. 3a).

At the final stage of treatment, an increase in the speckle-contrast parameter was revealed with visual confirmation of a decrease in the level of blood supply in the study area (Fig. 3c), which confirms the previously obtained data.

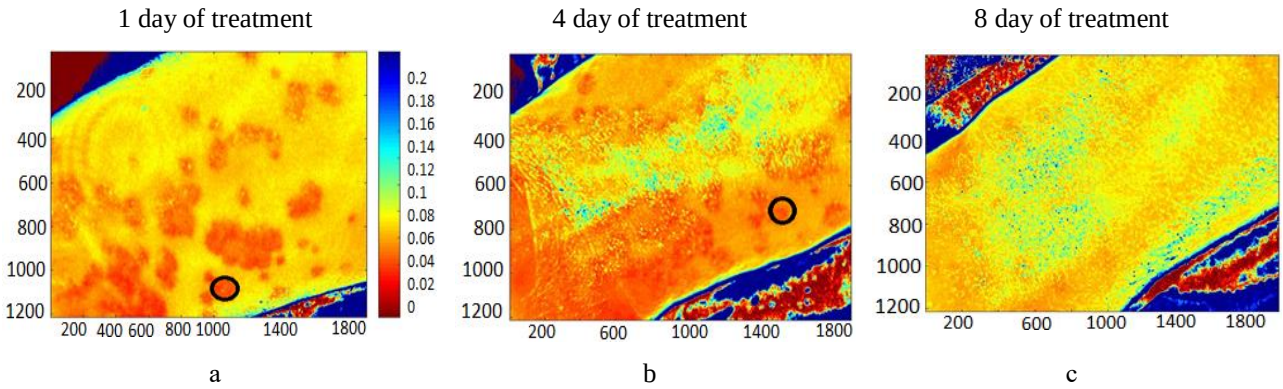

Figure 3 - Speckle picture of the inner surface of the forearm of a patient with psoriasis

Thus, the results of the studies show that the use of a multimodal approach combining three optical non-invasive technologies of VCS, LDF and LSCI, allows to detect microcirculatory disorders, at the preclinical stage of the study, when clinical symptoms have not yet been identified. In addition, this approach allows us to evaluate the effectiveness of the drug and instrumental treatment of patients with psoriasis, as well as the results of studies.

4. CONCLUSION

The proposed approach based on the multimodal approach, when introduced into the daily practice of a dermatologist, can be used to identify hidden disorders of the microvasculature at an early stage of the disease and evaluate the effectiveness of treatment of patients with psoriasis. This approach will allow timely provision of necessary medical care, prevent the occurrence of complications, which will significantly increase the effectiveness of existing therapy, reduce the patient's economic and time costs for treatment, significantly improving his quality of life.

The prospects for further research are seen in a more detailed study of disorders of the microvasculature using functional tests and new methods for visualizing the capillary network in the skin.

Studies have shown that significant results can be achieved with multidisciplinary research of microcirculation parameters and active cooperation between leading research groups in the field of optical research methods, computer analysis and image processing and medical specialists.

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