СОВРЕМЕННЫЕ ПОДХОДЫ К КОРРЕКЦИИ ФУНКЦИЙ НЕРВНОЙ И ИММУННОЙ СИСТЕМ (МОЛЕКУЛЯРНО-ГЕНЕТИЧЕСКИЕ МЕТОДЫ, СТВОЛОВЫЕ КЛЕТКИ И ДР.)

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REGULATION OF MICROCIRCULATION DURING REMODELING OF SKIN SCAR UNDER INFLUENCE OF LASER

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ОСОБЕННОСТИ РЕГУЛЯЦИИ МИКРОЦИРКУЛЯЦИИ ПРИ РЕМОДЕЛИРОВАНИИ КОЖНОГО РУБЦА ПОД ВЛИЯНИЕМ ЛАЗЕРНОГО ИЗЛУЧЕНИЯ

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An experimental study was fulfilled on 15 laboratory mail rats. After normotrophic skin scar modeling, the scar tissue was once exposed to high-intensive red, near or far infrared laser in comparable modes. Microcirculation parameters were assessed with laser Doppler flowmetry. It was found that the nature of microcirculation response to high-intensive laser irradiation substantially depended on the laser wavelength and its penetrating depth. Laser resurfacing of the skin scar with CO_2 laser in early period led to blood stasis in the vessels and decrease in the vascular wall tone against the background of sympathetic influence increase. The red and near-infrared lasers caused the increased arterial blood inflow and venular outflow, with local regulation by myogenic tone prevailing.

Keywords: laser; microcirculation; skin scar.

Проведено экспериментальное исследование на 15-ти лабораторных крысах, которым после моделирования нормотрофических кожных рубцов однократно воздействовали на рубцовую ткань высокоинтенсивным лазерным излучением красного, ближнего и дальнего инфракрасного диапазона в сопоставимых режимах. Оценивали параметры микроциркуляции методом лазерной допплеровской флуометрии. Установлено, что характер ответной реакции микрогемоциркуляции на высокоинтенсивное лазерное воздействие существенно зависит от длины волны лазерного излучения и его проникающей способности. Лазерная шлифовка кожного рубца излучением углекислого лазера в ранние сроки приводит к стазу крови в сосудах и снижению тонуса сосудистых стенок на фоне повышения симпатических влияний. Воздействие красного и инфракрасного лазера характеризуется усилением притока крови в артериальное звено и ее оттока через венулярное звено при преобладании местных регуляторных механизмов, реализующихся через миогенный тонус.

Ключевые слова: лазер; микроциркуляция; кожный рубец.

Introduction. The mechanism of action of red and near infrared laser radiation on the skin have been studied in sufficient detail, but the specific features of microcirculation rearrangement in the scar tissue have not been studied yet. The regulation of microcirculation depends on both the central neurogenic mechanisms, which are mainly realized through the sympathetic nervous system and myogenic tone, which is affected by autoregulation, the level of nitric oxide, stress-limiting factors and metabolites [1]. The purpose was a comparative study of microcirculation parameters in skin scars after their laser correction.

Material and methods. The experiment was carried out on 30 male rats with a model of skin scars in the paravertebral regions of the back. In the 1st and 2nd groups of animals, 660 nm and 1060 nm lasers with 2 W power were used in continuous mode for 3 minutes. In the 3rd group, an ablation with 10.6 μm laser was performed for 3 minutes with 0.5:1 ms pulse-to-pause ratio, 50 W pulse power and a spot diameter of 0.5 mm. The doses and densities of laser energy obtained by all animals were comparable. Laser Doppler flowmetry was performed with LAKK-01 (version 2.2.509). After a single laser exposure, measurement was taken from the right (experience) and left scar (dynamic control) for the following periods: immediately after the laser exposure, 1 hour and 1 day after. The statistical significance was assessed using the Mann-Whitney *U*-test.

Results and discussion. The integral microcirculation indicator significantly increased 1 hour and 1 day after treatment with near infrared laser radiation, and in other experimental and control groups it did not change significantly. The standard deviation ratio, which reflected the preservation of microcirculation regulation mechanisms, significantly increased 1 day after near-infrared laser treatment, and didn't change significantly in other groups at any of the dates. Sympathetic effects on the vascular wall were assessed by the neurogenic tone index, which significantly decreased 1 hour and 1 day after red and near infrared laser treatment relative to control values. This indicator increased significantly 1 day after laser dermabrasion with 10.6 μm laser. The indicator of myogenic tone allowed evaluating the work of smooth muscle elements of the vascular wall. It significantly increased 1 hour and 1 day after red and near infrared laser treatment relative to reference values; on the contrary, 1 day after CO_2 laser treatment this indicator decreased. The intravascular resistance increased in all periods of observation after near-infrared laser treatment, 1 hour and 1 day after red laser exposure; and the decrease of this indicator was observed 1 day after laser dermabrasion.

Conclusion. The microhemocirculation response to high-intensive laser irradiation substantially depends on the wavelength of the laser radiation and its penetration depth. Laser resurfacing of the skin scar with CO_2 laser in the early periods leads to blood stasis in the vessels and vascular wall tone decrease against the background of sympathetic influences increase. The red and near-infrared lasers caused the increased arterial blood inflow and venular outflow, with local regulation by myogenic tone prevailing.

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