Changes in Platelet Aggregability after Blood Irradiation by Helium-Neon Laser and Red Light Emitting Diodes

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We analyzed changes in platelet aggregability induced by therapeutic irradiation of the blood with red light from a helium-neon laser and light-emitting diodes. Blood irradiation by helium-neon laser or red light-emitting diodes is alternative procedure for the inhibition of platelet functions, particularly in the case of individual intolerance to certain drugs.

Key Words: *platelet aggregation; helium-neon laser; light-emitting diodes*

Blood irradiation with red light (λ=630 nm) from a low-energy helium-neon laser (HNL) has been widely used in the therapy of vascular diseases and disorders associated with secondary immunodeficiency. Moreover, this procedure stimulates proliferative processes. Light-emitting diodes (LED) with the maximum emission wavelength of 660 nm have been used as alternative red light sources. They were effective in the treatment of patients with bronchial asthma.

Here we studied the effects of blood irradiation by HNL and LEDs on platelet aggregability.

MATERIALS AND METHODS

Blood irradiation by HNL and LEDs was performed in 48 patients. The first group included 20 patients with bronchial asthma complicated by chronic obstructive bronchitis. Laser was used for blood irradiation in ten patients. In the remaining patients (n=10) blood was irradiated by LEDs. Blood irradiation was performed extracorporeally. The second group included 28 patients with second-stage obliterating atherosclerosis (Fontane) of leg arteries. Ten of these patients were treated with intravascular blood irradiation by using light-conducting fibers and the 1-mW HNL. The remaining patients (n=18) received extracorporeal blood irradiation. Each treatment session lasted 40 min.

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Extracorporeal blood irradiation was performed with an ELOK-1 device (State Optical Institute, St. Petersburg). The HNL beam with an output power of 1 mW was defocused in a 10-cm slit. Transparent plastic tube for the blood transfusion system was placed in this slit. The blood was taken from the cubital vein and placed into a sterile flask containing the 3.8% sodium citrate (1:10) Reinfusion was performed for 40 min.

Extracorporeal irradiation by LEDs was performed similary. We used the device in which a 10-cm segment of the tube for blood transfusion was illuminated by six LEDs of 1 mW each.

The course of the therapy included 4-6 procedures every other day.

Platelet aggregation was measured in an ELVI-840 platelet aggregometer. Aggregation was induced by ADP (2×10^{-5} M), epinephrine (2×10^{-6} M), and ristomycine (1.5 mg/ml).

RESULTS

Platelet suspension samples (0.45 ml each) were placed into plastic cuvettes to determine the effects of red light on the aggregation of blood plasma platelets. Light from the HNL or one LED was transmitted via these cuvettes for 1, 10, 100, and 1000 sec. The aggregation of platelets was monitored. This procedure was not accompanied by changes in platelet functions. Insignificant variations were probably due to instrumental errors.

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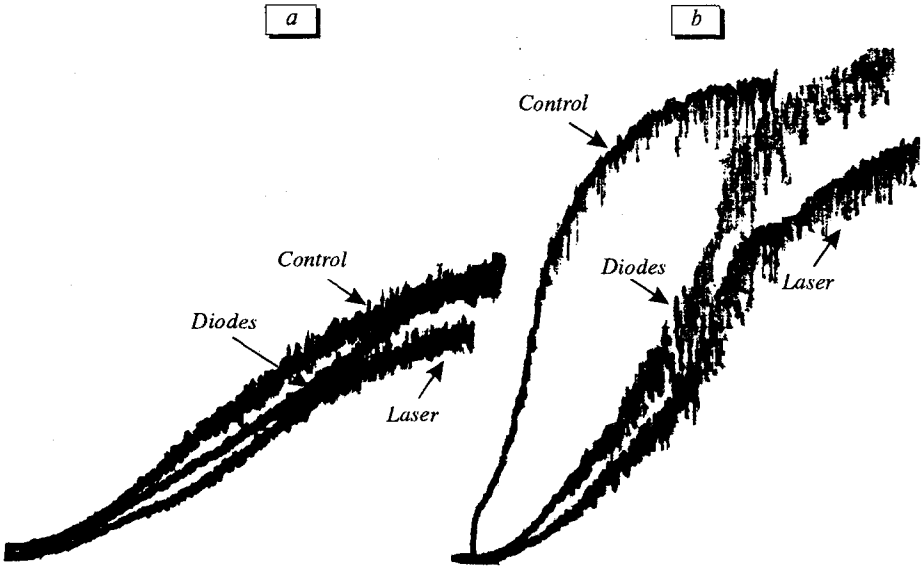

Fig. 1. Changes in the intensity of platelet aggregation induced by *a*) epinephrine and *b*) ristomycine after blood irradiation in vitro with a helium-neon and light-emitting diodes in the flow system (1 ml/12 sec).

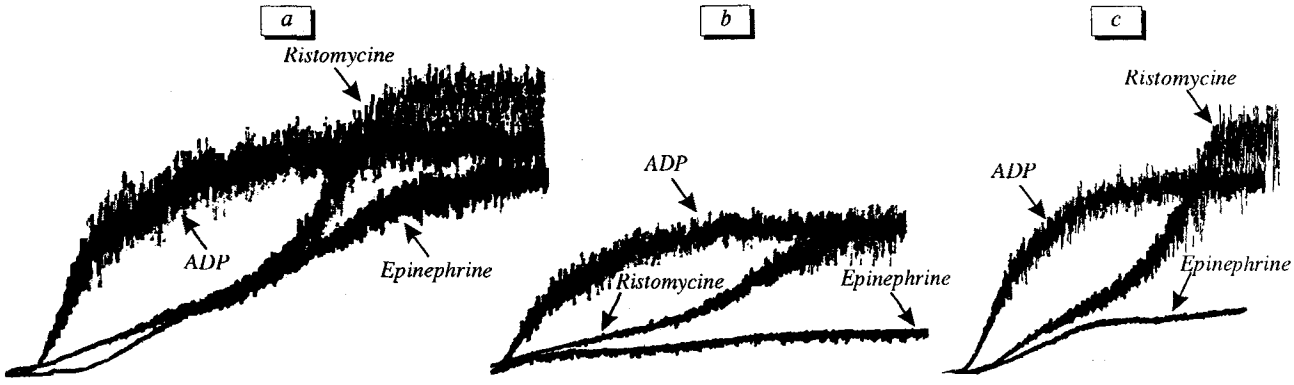

Fig. 2. Intensity of platelet aggregation *a*) in control and after irradiation with *b*) helium-neon laser and c) light-emitting diodes in the flow system (1 ml/120 sec).

Changes in platelet aggregation were then studied in irradiated blood. The aggregation rate decreased (especially during the use of the HNL) at the standard blood flow rate of 1 ml/12 sec in the irradiated region (Fig. 1). The maximum aggregation amplitude was unchanged during irradiation with LEDs and decreased during irradiation with HNL.

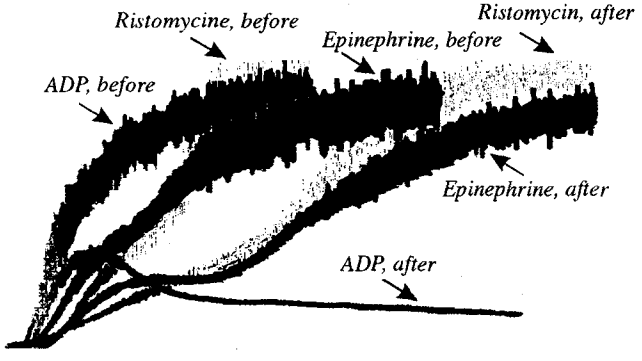

Fig. 3. Change in platelet aggregation in a patient with bronchial asthma after extracorporeal blood irradiation.

A tenfold increase in the irradiation dose caused a corresponding decrease in the blood flow rate, which inhibited platelet aggregation induced by all studied agents. The rate of primary aggregation, the size of aggregates, and the rate and amplitude of secondary aggregations decreased (Fig. 2). The inhibitory effect of HNL was more pronounced compared with that of LEDs.

Photohemotherapy with red light was performed. Blood sample taken from the vein before the procedure was compared with the blood sample taken from the vein of the other arm 3-5 min after the completion of reinfusion.

Platelet aggregation in 12 patients of the first group and 15 patients of the second group was above normal level. The remaining individuals admitted to the hospital displayed sharply inhibited aggregation of an outpatient treatment with antiaggregating agents.

The aggregation was strongly inhibited (Fig. 3 and 4) the rates of primary and secondary aggregation, the number of aggregated platelets, and the size of aggregates decreased platelet hyperaggregation imme-

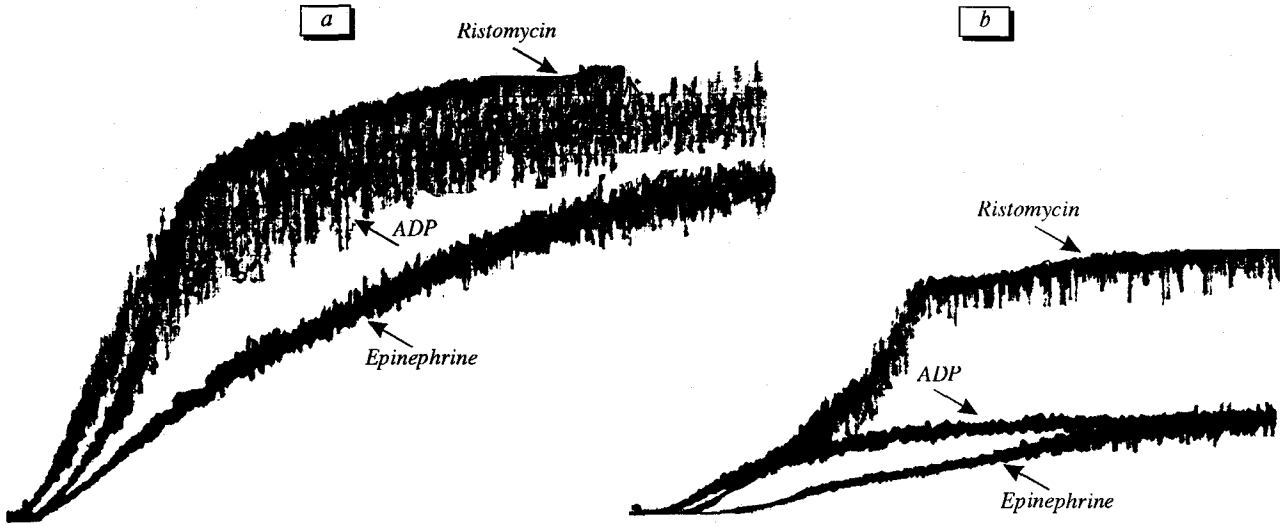

Fig. 4. Change in platelet aggregation in a patient with chronic arterial insufficiency *a*) before and *b*) after intravascular blood irradiation.

diately after the procedure. Figure 3 shows that these aggregates were unstable and readily disaggregated. After photohemotherapy, the degree of inhibition of platelet functions was different in various patients and varied in the course of therapy. The inhibition was extremely pronounced in several patients (Fig. 5). Blood irradiation did not cause any changes in patients with inhibited platelet functions.

Nephelometry showed that the number of circulating platelets did not change after reinfusion of irradiated blood. The degree of platelet inhibition did not depend on the method and source of irradiation. During extracorporeal blood irradiation, the volume of irradiated blood was obviously much smaller than during intravascular irradiation. However, the inhibitory effects were nearly similar.

The inhibitory effect was well pronounced in the whole body. However, it was insignificant under direct irradiation of the blood at the standard flow rate (Fig. 1). After the completion of the therapy, clinical improvement was accompanied by stable inhibition of platelet aggregability.

Thus, blood irradiation with HNL or LEDs may be an alternative procedure for the inhibition of platelet functions, particularly in the case of individual intolerance of certain drugs.

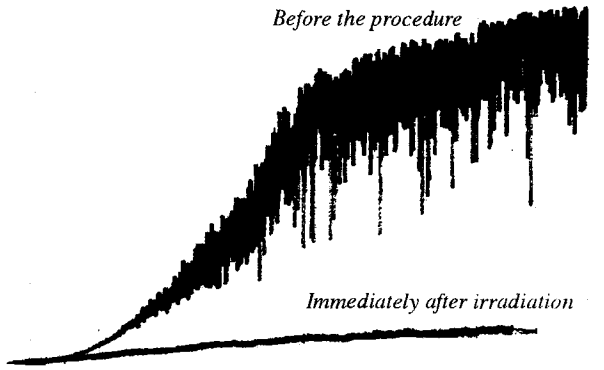

Fig. 5. Change of ristomycine-induced platelet aggregation in a patient with bronchial asthma after extracorporeal blood irradiation.

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