The Effect of Extracorporeal He-Ne Laser Exposure of the Blood on Erythrocyte Morphology and Function

O. I. Slinchenko, N. P. Aleksandrova, N. N. Kvitko, and A. A. Korneev

Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 123, No. 3, pp. 338-340, March, 1997
Original article submitted October 8, 1995

A single one-hour extracorporeal exposure of a large blood volume to He-Ne laser induces no negative changes in the morphology and function of erythrocytes at various stages of the experiment (immediately and 5, 15, and 30 days after the procedure).

Key Words: *erythrocytes; He-Ne laser; extracorporeal exposure of the blood*

Extracorporeal exposure of autologous blood to He-Ne laser has been used in clinical practice. This approach provides a unique possibility of purposeful exposure of formed elements and plasma without exposure of the vascular wall. However, our knowledge of this method is insufficient — just few cases have been reported [2-6], therefore, further experimental and clinical studies are needed.

In this study we examined the morphology and function of erythrocytes after extracorporeal exposure of a large volume of circulating blood to He-Ne laser.

MATERIALS AND METHODS

Experiments were carried out on 16 adult mongrel dogs of both sexes weighing 15-18 kg. Arteriovenous femoral shunt was created under thiopental anesthesia (1 g of thiopental intravenously for the entire operation). The femoral artery was cannuled from one side and the femoral vein from the other after injection of heparin in a dose of 300 to 500 U/kg. The cannulas were connected to a sterile disposable PK-11-05 flexible 3-mm tube for infusion of blood substitutes and other solutions; this ensured sterility of the procedure and ruled out contacts of the blood flowing through the system with the environment. Six animals served as controls. An Izol'da-ELOK laser with a wavelength of 632.8 nm and energy 10 W/m was used for a single extracorporeal exposure of the blood in 10 dogs. The rate of blood flow in the system was 100 ml/min, the duration of session was 1 h. The volume of photomodified blood was about 5-6 volumes of circulating blood. This was a specific feature of our experiment, because in clinical practice smaller volumes of blood are exposed — 2-2.5 ml/kg b.w. Blood samples for analysis were collected from the peripheral vein of the hind limb before, immediately after, and on days 5, 15, and 30 after the exposure.

The erythrocyte is the classical object for investigation of different processes induced by strained homeostasis. In addition, the erythrocyte membrane is a universal model of cell membranes [7].

Erythrocyte count, cell diameter, osmotic resistance, deformability (filterability), and hemoglobin content were determined [1].

RESULTS

In controls, erythrocyte count and hemoglobin level in peripheral blood were slightly decreased immediately after the operation. The osmotic resistance and deformability of erythrocytes decreased (Table 1), but all these changes were statistically insignificant. From these findings we concluded that the

Academician N. R. Paleev Research Group, Moscow

0007-4888/97/0003-0293$18.00

TABLE 1. Time Course of the Morphology and Function of Erythrocytes of Intact Dogs and After Extracorporeal He-Ne Laser Exposure of the Blood

Parameters	Period of examination				
	before exposure	after exposure			
		directly	day 5	day 15	day 30
Controls (*n*=6)					
Count of erythrocytes, 10^6/liter	3.98±0.17	3.72±0.18	3.91±0.19	4.06±0.19	4.07±0.17
Diameter of erythrocytes, %					
6.7-7.2 μ	65.4±1.9	65.0±2.0	64.4±1.7	76.7±2.4	67.4±1.7
7.7-9.2 μ	19.5±1.7	19.9±1.8	20.3±2.1	17.3±1.9	17.7±1.6
Osmotic resistance of erythrocytes, %	79.8±4.6	84.8±5.1	81.3±5.8	80.8±4.1	80.2±4.4
Filterability of erythrocytes, ml/3 min	5.2±0.2	4.7±0.2	4.9±0.3	5.0±0.2	4.9±0.2
Hemoglobin content, g/liter	138±6.3	132±5.9	133±5.7	135±6.9	137±7.1
After He-Ne exposure (*n*=10)					
Count of erythrocytes, 10^6/liter	4.23±0.19	4.48±0.18	4.18±0.19	4.22±0.19	4.31±0.15
Diameter of erythrocytes, %					
6.7-7.2 μ	68.1±2.6	68.4±2.4	67.3±2.8	65.9±2.4	68.2±2.3
7.7-9.2 μ	17.0±2.1	16.7±1.9	17.3±1.9	19.0±1.8	16.8±1.7
Osmotic resistance of erythrocytes, %	81.8±3.9	83.3±4.1	83.4±3.8	86.3±3.4	82.1±4.3
Filterability of erythrocytes, ml/3 min	5.0±0.2	5.0±0.3	5.3±0.2	5.6±0.3	5.0±0.2
Hemoglobin content, g/liter	142±5.1	148±5.8	141±5.6	143±6.2	144±6.2

supine position and one-hour procedure cause no appreciable changes in the morphology and function of erythrocytes.

Immediately after extracorporeal He-Ne exposure of the blood, the fluctuations in erythrocyte count, level of hemoglobin, cell diameter, osmotic resistance, and filterability were negligible and statistically insignificant (Table 1).

On day 5, there were no significant changes in erythrocytes. The content of hemoglobin and erythrocyte count slightly differed from the initial values. The osmotic resistance and diameter of erythrocytes were virtually normal. The filterability of erythrocytes was higher ($p>0.005$), indicating an improvement of their viscosity and elasticity.

On day 15, the tendency toward further improvement of erythrocyte filterability was still observed: this parameter was 12% higher than initially. The erythrocyte count, hemoglobin level, osmotic resistance, and diameter of cells were little changed in comparison with the initial values.

On day 30, all the parameters characterizing the morphology and function of erythrocytes were close to the pre-exposure values.

Thus, our results show that one-hour He-Ne exposure of the blood results in appreciable (increased filterability) and persistent (up to 30 days) changes in erythrocyte properties. From the absence of hemolysis and microfragmentation of erythrocytes (stable osmotic resistance) at various stages of the experiment it can be concluded that He-Ne exposure of large volumes of the blood does not lead to pathological changes in erythrocytes. Our results may serve as additional confirmation of the efficacy of extracorporeal methods of irradiation of large volumes of circulating blood.

REFERENCES

1. V. V. Men'shikov *et al.* (Eds.), *Laboratory Methods of Investigation in Clinical Practice. A Handbook* [in Russian], Moscow (1987).
2. N. R. Paleev, V. A. Il'chenko, P. P. Golikov, *et al.*, *Ter. Arkh.*, No. 12, 56-59 (1994).
3. Yu. V. Popov, L. M. Kukui, and O. G. Sorokina, in: *Use of Lasers in Surgery and Medicine* [in Russian], Pt. 2, Moscow (1988), pp. 35-36.
4. Yu. V. Popov, L. M. Kukui, E. A. Faktor, *et al.*, in: *Effects of Low-Energy Laser on the Blood* [in Russian], Kiev (1989), pp. 144-146.
5. I. A. Sadovnikova, "Effect of extracorporeal laser exposure of the blood on the peripheral hemodynamics, blood rheology, and platelet aggregation in patients with obliteraing atherosclerosis of the lower limb arteries," Author's Synopsis of Cand. Med. Sci. Dissertation [in Russian], Moscow (1993).
6. A. V. Strutynskii, I. A. Sadovnikova, E. B. Petukhov, *et al.*, in: *Prospective Trends in Laser Medicine* [in Russian], Moscow - Odessa (1992), pp. 222-224.
7. E. A. Chernitskii and A. I. Vorobei, *The Structure and Function of Erythrocyte Membranes* [in Russian], Minsk (1981).