bances of cardiac function after exposure to EPS.

The results given in Table 1 show that ionol, an inhibitor of POL, did not affect the Ca-transport system in SR of the control animals but prevented the decrease in Ca^{++} accumulation and in Ca-ATPase activity in EPS. This suggests that POL is the main cause of the disturbance of Ca^{++} transport in EPS.

Disturbance of the enzyme system for Ca^{++} ion transport in SR membranes (a decrease in Ca-ATPase activity and an increase in membrane permeability) is due to activation of POL and can be prevented by administration of a POL inhibitor. This means that injury to the membrane system for Ca^{++} transport by POL products is in fact the key stage of stress injury to the heart, and that administration of antioxidants affords prospects for the prevention of such injuries.

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EFFECT OF HYPERBARIC OXYGENATION ON LOCAL TISSUE BLOOD FLOW IN A GRAFT OF SMALL INTESTINE INTENDED FOR ESOPHAGOPLASTY

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Intestinal esophagoplasty is widely used in reconstructive surgery for esophageal obstruction [9, 6]. A serious complication of plastic reconstruction of the esophagus is partial or total necrosis of the graft [4]. These complications are connected with disturbance of the circulation in the graft, the main predisposing causes of which are ligation of some of the mesenteric vessels and the subsequent traumatic manipulations with the graft. To begin with the microcirculation is disturbed, and this largely determines the outcome of the plastic operation and the efficacy of treatment [8]. This makes it clear that one way of improving the viability of an intestinal graft is through correction of the disturbances of its microcirculation.

The method of hyperbaric oxygenation (HBO) has been widely used for the treatment of circulatory disturbances [5]. This method allows the partial pressure of oxygen in the tissues to be increased, with a consequent improvement of the microcirculation of the organ.

Among suggested methods of improving the microcirculation of the intestinal graft, our attention was drawn to a report by Chernousov et al. [7] on the use of HBO for the prevention of graft necrosis. However, no reference could be found in the literature to any previous investigations aimed at quantitative assessment of the state of the microcirculation of an intestinal graft intended for esophagoplasty and treated with HBO.

The object of this experimental study was accordingly to examine the microcirculation in the muscular layer of a graft of small intestine designed for esophagoplasty, using HBO to correct any ischemic disturbances in the graft.

KEY WORDS: esophagoplasty; hyperbaric oxygenation; tissue blood flow.

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TABLE 1. Dynamics of Changes in λ of Tissue Blood Flow in Different Parts of Graft of Small Intestine

Region of graft	Initial value (intact intestine; n = 34)	Immediately after end of excision of graft (n = 34)	1.5 h after end of excision of graft (n = 14)
Distal end	0,2275±0,0220 (100 %)	0,0232±0,0055 (10 %)	0,0205±0,0022 (9%)
Middle	0,2275±0,0220 (100 %)	0,0781±0,0175 (34 %)	0,0344±0,0055 (15%)
Base	0,2275±0,0220 (100 %)	0,1472±0,0507 (64 %)	0,0728±0,0236 (32%)

TABLE 2. Changes in Value of λ of Tissue Blood Flow in Different Parts of Graft of Small Intestine Treated with HBO

Region of graft	Initial value (immediately after end of excision of graft; n = 34)	After session of HBO (2 atm, 60 min; n = 20)	Control (1.5 h after end of excision of graft, without treatment; n = 14)
Distal end	0,0232±0,0055 (100 %)	0,0534±0,0123 (230 %)	0,0205±0,0022 (88 %)
Middle	0,0781±0,0175 (100 %)	0,0806±0,0138 (103 %)	0,0344±0,0055 (44 %)
Base	0,1472±0,0527 (100 %)	0,1458±0,0136 (99 %)	0,0728±0,0236 (49 %)

EXPERIMENTAL METHOD

Altogether 54 acute experiments were carried out on male rabbits weighing from 4 to 6 kg. Intravenous injection of pentobarbital in the usual doses was given for anesthesia. The graft of small intestine was mobilized by the Roux–Gertsen–Yudin method, with ligation of three to six pairs of intestinal vessels (arteries and veins).

The state of the microcirculation was assessed from the local tissue blood flow of the muscular layer of the small intestine. The tissue blood flow was determined by the method of ^{133}Xe clearance from the muscular layer [1, 10]. The criterion of magnitude of the microcirculation (the local tissue blood flow) was the index λ, defining the fraction of the isotope excreted from the tissue depot in unit time. The value of λ has been shown to determine the level of the capillary blood flow [1]. The higher the capillary blood flow, the greater the value of the index λ.

Two series of experiments were conducted. In series I (34 rabbits) the tissue blood flow was studied in different parts (base, middle, and distal end) of the graft of small intestine.

In the experiments of series II the state of the microcirculation in these same parts of the graft was determined after exposure to HBO.

The microcirculation was studied in the intact intestine after isolation of the graft (1.5 h after the beginning of the operation, 1.5 h after excision of the graft, or after the end of the HBO session — 2 atm, exposure 60 min).

EXPERIMENTAL RESULTS

The tissue blood flow in the muscular layer of different parts of the intact small intestine, from which the graft would subsequently be excised, was shown to be constant, with a value $\lambda = 0.23 \pm 0.02$. Changes in the value of λ of the tissue blood flow in different parts of the graft of the small intestine immediately after its incision and 1.5 h later in the absence of treatment are given in Table 1.

Immediately after the end of excision of the graft the value of λ for the tissue blood flow differed in different parts of the graft: λ of tissue blood flow at its base was 0.1472 ± 0.0507, and in the middle of the graft it was 0.0781 ± 0.0175. The smallest value of the tissue blood flow was discovered in the distal portion of the graft ($\lambda = 0.0232 \pm 0.0055$).

Consequently, immediately after excision of the graft the tissue blood flow was at its lowest level in the distal portion compared with that in the intact intestine. Whereas the tissue blood flow at the base of the graft immediately after its excision was 64% of the tissue blood flow of the intact intestine, and in the middle it was 34%, in the distal portion the blood flow through the microcirculatory system was reduced by 90% compared with the blood flow of the intact intestine. With an increase in the period of ischemia of the graft (1.5 h after the end of excision) the tissue blood flow in its different regions was depressed still

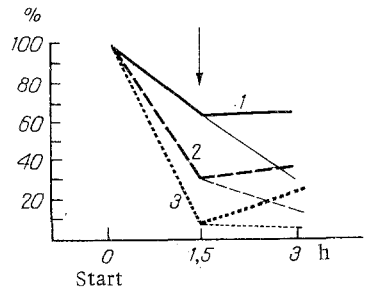

Fig. 1. Dynamics of tissue blood flow in intestinal graft under the influence of HBO. Abscissa, duration of ischemia (in h); ordinate, tissue blood flow (in % of initial value taken as 100). 1) Base of graft; 2) middle; 3) distal end of graft; bold lines indicate experiment, thin lines control. Arrow shows beginning of treatment with HBO (1 h, 2 atm).

more. The tissue blood flow at the base of the graft 1.5 h after its excision was 32% of the blood flow of the intact small intestine, 15% in the middle, and 9% in the distal end.

It can be concluded from these results that during excision of the graft and also 1.5 h after the end of excision there is a severe disturbance of the microcirculation of the muscular layer of the graft of small intestine. The severest changes in the microcirculation of the graft occurs in its distal portion.

These results are in agreement with those of Novosel'tsev [3], who showed that the volume of the blood flow in the distal portion of the graft is reduced by 75% compared with the blood flow of the intact intestine, and they confirmed the practical importance of treating microcirculatory disturbances in a graft of small intestine intended for esophagoplasty.

Data on changes in the value of λ of the tissue blood flow in different parts of the graft of small intestine treated with HBO are given in Table 2.

They show that after the end of the HBO session the dynamics of the tissue blood flow in different parts of the graft differs. The microcirculation at the base of the graft under the influence of HBO remained unchanged compared with the blood flow in it immediately after the end of excision. In the control (1.5 h after excision of the graft, without treatment) a decrease was observed in the tissue blood flow at the base of the graft to 49% of its initial value (immediately after the end of excision). These values are evidence that HBO doubles the microcirculation at the base of the graft compared with the control level.

The microcirculation in the middle part of the graft of small intestine was not significantly reduced under the influence of HBO. Compared with the control, however, the level of the blood flow in the middle part of the graft was increased by 2.34 times as a result of HBO.

A somewhat different picture was observed when the dynamics of the tissue blood flow of the distal part of the graft was studied. Exposure to HBO immediately after the end of excision of the graft led to an increase in its microcirculation by 2.3 times. Compared with the control, the microcirculation of the graft was increased by 2.6 times.

Exposure to HBO thus caused a significant increase in the microcirculation in different parts of a graft of small intestine, and this can serve as objective proof of the value of HBO in the treatment of microcirculatory disturbances.

It must, however, be pointed out that, despite the effective increase in the tissue blood flow of the graft, HBO does not equalize the blood flow in the microcirculatory system in the different parts of the graft (Fig. 1).

After treatment with HBO the values of the tissue blood flow in the distal portions of the graft remained lower than in the middle and at its base. Despite the marked improvement in the microcirculation, the values of the tissue blood flow in its different parts did not reach those of the blood flow in the intact intestine.

HBO evidently produces its effect on the microcirculation of the graft of small intestine by the same mechanisms as it produces its effect on ischemized muscle tissue [2].

Among the basic mechanisms of the action of HBO on the tissue blood flow its effect on the state of metabolism in the tissues of the graft and also on the state of the neurohumoral systems regulating the functional state of cells of the intestinal graft must be emphasized. Among these systems, a special role is played, as our data show, by cyclic nucleotides (cyclic AMP and GMP).

These investigations thus demonstrated that HBO is an effective method of treatment of ischemic injuries in a graft of small intestine intended for esophagoplasty.

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ANTIATELECTATIC FUNCTION OF LUNG SURFACTANT

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The results of numerous investigations show that certain pulmonary complications are connected with a disturbance of the surface activity of the surfactant [1]. In particular, replacement of surfactant *in vivo* by a component with less surface activity leads to atelectasis of the lung [5]. However, there are as yet no sufficiently reliable and informative criteria with which to determine relationships of cause and effect between the properties of the surfactant and the pathological state of the lung. Moreover, results throwing doubt on the role of surfactant in the maintenance of normal alveolar structure have been published [4]. Accordingly theoretical studies of the properties of the surfactant and its role in lung function are particularly important.

The writers previously suggested a mathematical model of the surface activity of surfactants. They showed that the basic properties of surfactant (change in surface tension, relaxation hysteresis) can be well described by a system of differential equations:

$$\begin{cases} \dfrac{d\sigma}{dt} = f(\sigma)\dfrac{1}{S}\dfrac{dS}{dt} + (\sigma_0 - \sigma)\dfrac{1}{\tau} \\ \dfrac{d\sigma_0}{dt} = \varkappa(\sigma - \sigma_0) + \eta(\sigma_1 - \sigma_0), \end{cases}$$

where σ is the surface tension; $f(\sigma)$ a function of the state of the surfactant; S the surface area; τ, $\varkappa$, η, σ_1 are constants.

The critical condition for normal surface activity of the surfactant $f(\sigma) > \sigma/2$ was calculated for use with the model. When this condition is disturbed, an alveolus of spherical shape will be unstable and will quickly collapse, and this could cause atelectasis of the lung.

KEY WORDS: lung surfactant; surface activity; atelectasis of the lung.

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