

EFFECT OF HYPERTONIC SALINE ON DISTRIBUTION OF DYE IN THE ORGANS  
AND THORACIC DUCT LYMPH

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The penetration of Trypan Blue into various tissues and the lymph was studied in acute experiments on 84 dogs receiving an injection of 5% sodium chloride solution (0.5 ml/kg). In intact animals the greatest accumulation of dye took place in the liver, kidney, and intestine. The osmotic shift due to intravenous injection of the hypertonic solution increased the hyaluronidase activity of the blood plasma, shortened the time of maximal dye accumulation in the tissues, and increased its concentration in the organs by 1.5-2 times.

KEY WORDS: *Lymphatic system; distribution of dye; blood hyaluronidase activity; osmotic shift.*

A shift in the osmotic pressure of the blood is accompanied by changes in cardiac activity [9], the tone of the lymphatic and blood vessels [5], permeability of the tissue-blood barriers [10], the total protein concentration in the lymph and blood plasma [4] and the lymph flow [1, 9]. The intensity and duration of these changes in different organs depends on their sensitivity, which can be estimated from the intensity of their vital staining [3].

The object of this investigation was to study the dynamics of accumulation of Trypan Blue in various tissues and its concentration in the thoracic duct lymph after administration of hypertonic saline and, on that basis, to assess the state of those tissues and of the lymphatic circulation.

#### EXPERIMENTAL METHOD

Experiments were carried out on 84 adult dogs (6-10 kg) anesthetized with morphine and hexobarbital (0.5 ml/kg of 2% morphine hydrochloride, 0.3 ml/kg of 10% hexobarbital solution). Trypan Blue was injected into the femoral vein in a dose of 0.02 g/kg [16]. Samples of blood and of lymph from the thoracic duct were taken from the dogs 1-30 min after injection of the dye; various organs (liver, kidneys, small intestine, spleen, lymph glands) were removed, washed with warm (38°) physiological saline, and examined with the SFD-2 instrument at a wave length of 600 nm (with an OS-14 filter) to determine the concentration of the dye. Determinations were carried out on control animals and also on dogs receiving an intravenous injection of 0.856 M NaCl solution (0.5 ml/kg body weight). The effect of the hypertonic solution on the blood hyaluronidase activity also was determined [11]. The results were subjected to statistical analysis [6].

#### EXPERIMENTAL RESULTS AND DISCUSSION

Trypan Blue, when injected into the femoral vein was found in all the tissues studied after 1 min, and in the thoracic duct lymph after 5 min. The quantity of dye in the tissues reached a maximum in the first 20 min and then decreased.

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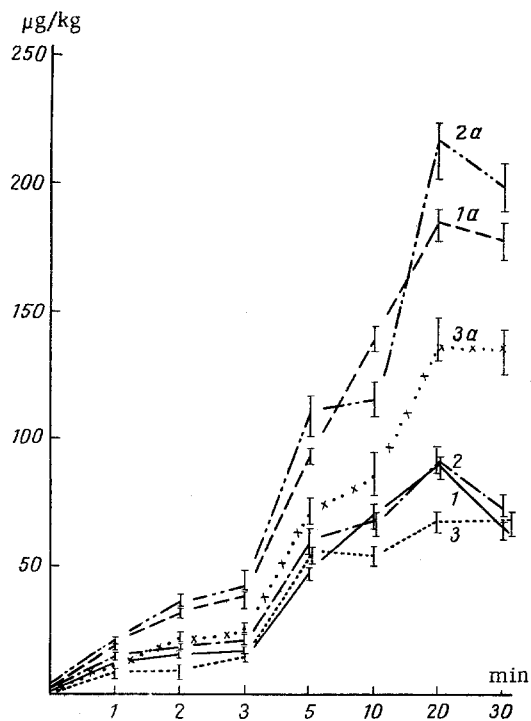


Fig. 1

Fig. 1. Dynamics of accumulation and elimination of Trypan Blue in various organs of dogs: 1) liver; 2) kidney; 3) intestine of control animals; 1a, 2a, 3a) corresponding organs of experimental animals. Ordinate, content of dye (in  $\mu\text{g/kg}$ ); abscissa, time after injection of dye (in min). Values of  $M \pm m$  given.

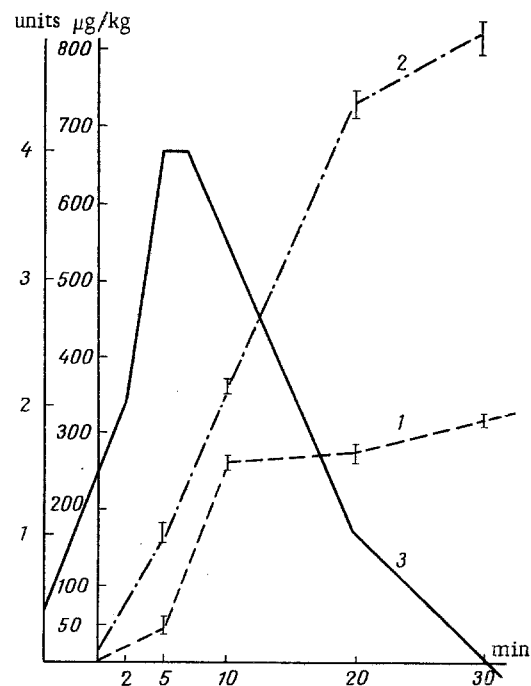


Fig. 2

Fig. 2. Dynamics of accumulation of Trypan Blue in lymph (1, 2) and hyaluronidase activity (3) of blood plasma of dogs: 1) control animals; 2) experimental animals. Left ordinate represents hyaluronidase activity (in units). Remainder of legend as in Fig. 1.

After the osmotic shift in the blood, accumulation of the dye in the tissues took place 1.5-2 times faster ( $P < 0.05$ ) (Fig. 1).

Dye was found in the thoracic duct lymph of the control dogs after 5 min in a concentration of  $48.6 \pm 0.001 \mu\text{g/liter}$ ; its concentration after 10 min was  $276.1 \pm 0.02 \mu\text{g/liter}$ . The concentration of dye in the lymph of the experimental animals at the same times was  $167.6 \pm 0.09$  and  $358.3 \pm 0.06 \mu\text{g/liter}$  respectively (Fig. 2). An initial sharp decrease, followed by a slower decrease in the concentration of dye in the blood plasma was observed in the experimental animals. The unequal accumulation of Trypan Blue in the various organs of the animals was evidently due to differences in the permeability of the capillaries of those organs [7, 13], which depend on the organ specificity of the cells, the biological activity of the endothelium of the walls of the lymphatic capillaries, and the functional activity of the organ [4].

Differences between the control and experimental series were probably due to changes in the permeability of the capillaries under the influence of the osmotic shift [10]. Vascular permeability is connected with the activity of mucolytic and proteolytic enzymes [15]. As a component of pericapillary membranes [14] and filling the space between the endothelial cells of vessels [15], the ground substance is the material substrate of permeability [8]. Hyaluronic acid is by far the most important component of the acid mucopolysaccharides of the ground substance [2]. The effect of the osmotic shift on the hyaluronidase activity of blood plasma was accordingly investigated.

The results showed that the hyaluronidase activity of the plasma was unchanged 30-60 sec after injection of the dye; in the second minute a small increase was observed, followed by a sharp increase after 7-10 min. The increase in hyaluronidase activity, the decrease in the dye concentration in the blood, and the increase in the dye content in the tissues and lymph were thus interconnected.

Injection of a hypertonic solution is followed by redistribution of the fluid volumes in the body [9]. The displacement of fluid and increase in permeability of the blood capillaries of individual organs during the osmotic shift are responsible for the intensification of lymph formation [12]. Newly formed portions of lymph are intensively resorbed by lymphatic capillaries, as is shown by an increase in the concentration of the dye in the thoracic duct lymph.

The results show that intravenous injection of a hypertonic solution leads to the more rapid transport of the macromolecular dye from the blood into the organs and lymphatic system, i.e., it increases the rate of penetration of the dye into various tissues.

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