COMPARATIVE STUDY OF FLOW AND PROTEIN COMPOSITION OF LYMPH IN THE RIGHT AND COMMON THORACIC DUCTS OF DOGS

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The mean total protein concentration in lymph of the right thoracic duct of healthy dogs is 26% lower, and the rate of lymph flow is 12 times lower, than in the common thoracic duct, and the rate of transfer of labeled protein from the blood is lower than in lymph of the common thoracic duct. The relative content of protein fractions is identical in the lymph of both ducts and in the blood serum. The absolute content of protein and protein fractions falls in the following order: blood serum > lymph of common thoracic duct > lymph of right thoracic duct. A modified method of obtaining lymph from the right thoracic duct is described.

The object of the investigation described below was to make a quantitative study of the lymph flow and fractional composition of the lymph proteins in the right and common thoracic ducts of healthy dogs.

EXPERIMENTAL METHOD

The lymph flow and protein composition of the lymph were studied in the right thoracic duct of 9 dogs (weighing 12-25.5 kg) and in the common thoracic duct of 6 dogs (weighing 8.5-23 kg). Lymph from the right (pulmonary) thoracic duct was obtained by making a lymph receptacle in an acute experiment (without thoracotomy) in the external jugular vein (in the region of the right venous angle) [4, 5].

Under chloral hydrate anesthesia (5-8 ml 10% solution intravenously every 30-40 min), the right external jugular vein was dissected as far as its junction with the right internal jugular vein. A glass tube 5-7 cm in length and similar in diameter to the internal lumen of the vein was introduced into the right external jugular vein. The central end of the tube reached the lumen of the right innominate vein after receiving the right subclavian vein, and the tube was fixed there by a ligature. The peripheral end of the tube was fixed in the lumen of the external jugular vein before the latter received the right internal jugular vein. All other veins entering the right external jugular vein in the region of the right venous angle were ligated 1-2 cm from their junctions. The cervical and brachial lymph ducts were also ligated 2-3 cm from their presumptive point of entry into the right venous angle. Blood from the right external jugular vein, by-passing the artificial receptacle, flowed freely through the glass tube into the right innominate vein. A plastic or glass catheter was inserted through the right cephalic or right internal jugular vein into the isolated cavity, and through it the cavity was washed with heparin solution to remove blood, and the lymph was collected in graduated centrifuge tubes. Between 10 and 15 min before the beginning of the surgical manipulation in the region of the right venous angle, 1000 i.u. heparin in 5-10 ml 2% procaine solution was injected through a plastic catheter through the dogs' trachea into the right bronchus. Lymph from the common thoracic duct was obtained by direct cannulation of the duct [1, 3].

To determine the rate of transfer of protein and its fractions from blood into lymph in the two ducts, labeled homologous serum proteins were injected intravenously. To obtain homologous proteins with high specific radioactivity, methionine-S^{35} was injected five times intravenously, every 2 h, in a

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TABLE 1. Indices of Lymph Flow and Total Protein Concentration in Lymph of Right and Common Thoracic Ducts and in Blood Serum of Healthy Dogs

Index	Dogs (9) with isolated right thoracic duct	Dogs (6) with isolated common thoracic duct
Total protein concentration in blood serum, g%	6.7	6.6
Lymph flow, ml/kg/h	0.18	2.20*
Total protein concentration in lymph, g%	2.8	3.8*
Outflow of protein with lymph, mg/kg/h	5.3	86.2*

*$P < 0.05$ compared with indices for lymph from right thoracic duct.

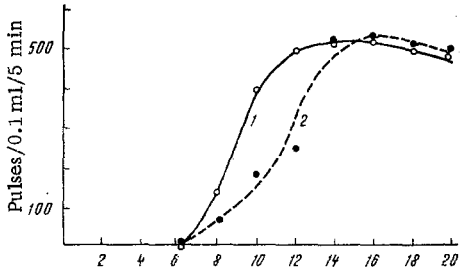

Fig. 1. Rate of appearance of dynamics of transfer of labeled protein from blood into lymph of common (1) and right (2) thoracic ducts. Abscissa, time (in min); ordinate, radioactivity of lymph.

dose of 0.3-0.8 mCi/kg, into donor dogs with ligated ureters. Blood was taken 13-15 h later and the serum separated from it and injected into experimental dogs. Labeled serum was given in a dose of 5-8 ml/kg (mean dose 112,000 pulses/ml over a period of 5 min).

The intensity of lymph flow (in mm/kg/h), and total protein concentration in the lymph of the right and common thoracic ducts and in the blood serum (in g%) were determined in all dogs by means of an IRF-22 refractometer. The ratio between the protein fractions in the blood serum and lymph of both thoracic ducts was investigated by paper electrophoresis using veronal-medinal buffer (pH 8.6; $\mu = 0.1$); the ratio between the labeled fractions was determined by radiometry of corresponding bands on the paper after electrophoresis [2]. Counting of each fraction continued for 30 min. The radioactivity of the blood serum and lymph from both thoracic ducts was counted after drying (95-100°) of the samples (0.1 ml) in three parallel tubes for 5 min in a B-3 apparatus using a BFL end-window counter housed in lead. The quantity of protein flowing from the right and common thoracic ducts was calculated in mg/kg/h from values of the volume of lymph flow per hour and the concentration of total protein in the lymph.

RESULTS

The experiments (Table 1) showed that in dogs with isolated right and common thoracic ducts the difference in total protein concentration in the blood serum is not statistically significant.

The lymph flow in the right thoracic duct was 12 times slower, the concentration of total protein in the lymph 26% lower, and the quantity of protein flowing out with the lymph 16 times less than in the common thoracic duct. The total protein concentration in the lymph of the right thoracic duct was 42% and in lymph of the common thoracic duct 54% of the total protein concentration in the blood serum.

The rate of appearance of intravenously injected protein labeled with methionine-S^{35} (Fig. 1) in lymph of the right thoracic duct was on the average slightly slower (8 min) than in lymph of the common thoracic duct (7 min).

Electrophoresis of the lymph from the right and common thoracic ducts of healthy dogs revealed, just as in the blood serum, eight protein fractions (one albumin and seven globulins). The relative content of albumin and of globulin fractions and the A/G ratio were the same for lymph from both ducts.

Radiometric determination of the labeled protein fractions showed that all fractions of intravenously injected labeled homologous serum proteins passed from the blood into the lymph of both lymphatic ducts. The relative content of labeled albumin, the A/G ratio, and the content of labeled globulin fractions in the lymph of both ducts and in the blood serum were equal and virtually indistinguishable from their relative content in labeled donors' blood serum.

A study of the protein composition of lymph from both thoracic ducts and of the blood serum together with the study of transfer of labeled serum into the lymph showed that lymph of both ducts con-

tained all protein fractions and in the same proportion as in serum. The absolute protein content was greatest in the blood serum and least in the lymph of the right thoracic ducts. In its protein content, lymph of the common thoracic duct occupied an intermediate position. Given an identical relative content of the protein fractions, their absolute contents therefore decreased in the following order: blood serum > lymph of common thoracic ducts > lymph of right thoracic duct.

Both the concentration of protein and of protein fractions and the rate of flow of proteins were thus higher in the lymph of the common thoracic duct than in lymph of the right thoracic duct. This result can be explained by the high permeability to proteins of the liver sinuses because lymph flowing from the liver constitutes a high proportion of the lymph in the common thoracic duct.

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