MECHANISMS OF CHANGES IN COMPOSITION OF SERUM PROTEIN FRACTIONS AFTER DISTURBANCE OF THE PANCREATIC EXOCRINE FUNCTION

E. P. Fenina

UDC 616.37-008.6-07:616.153.96-074

In disturbances of the pancreatic exocrine function in dogs similar changes arise in the composition of the serum protein fractions whether the pancreatic juice is lost or not.

Disturbance of the exocrine function of the pancreas in dogs with the pancreatic duct exteriorized may lead to substantial changes in the blood serum protein spectrum: well-marked dysproteinemia, a decrease in the albumin-globulin ratio, and the appearance of an additional globulin fraction between the β- and α_2-globulins [11, 12]. Intensive protein synthesis in the pancreas [14, 16, 19] evidently is maintained by the abundant supply of building materials reaching the pancreas from the blood stream, especially serum albumin, the nitrogen reservoir of the body [9, 10].

The object of the present investigation was to determine whether these changes are connected with the loss of protein by the body or whether they are due to a disturbance of the exocrine function of the pancreas.

EXPERIMENTAL METHOD

In the experiments of series I on dogs with the pancreatic duct exteriorized by Pavlov's method for 5-8 weeks the composition of the serum protein fractions was determined parallel with the loss of proteins with the pancreatic juice for 3 h before the animal received a mixed feed (1 liter milk, 200 g bread, 100 g stewed meat and multivitamin preparations). To judge the exocrine function of the pancreas, the blood levels of trypsin [13, 15] and amylase [5] were investigated. In the experiments of series II the relative proportions of the serum protein fractions were studied in 2 dogs with a disturbed pancreatic exocrine

TABLE 1. Albumin-Globulin Ratio and Volume of Pancreatic Juice in Dogs with Pancreatic Duct Exteriorized by Pavlov's Method

Dog's name	Satisfactory state		Pancreatic function disturbed	
	albumin-globulin ratio	volume of juice (in ml)	albumin-globulin ratio	volume of juice (in ml)
	$M \pm m$			
Zhuchok	0,91±0,030	12±3	0,62±0,040	34±5
Kashtan	0,85±0,017	15±1,8	0,41±0,048	33±5,7
Akbar	0,61±0,025	84±7,0	0,30±0,009	43±8,0
Bobik	0,61±0,026	63±4,2	0,41±0,049	15±3,8
Dzhaz	0,85±0,071	1,3±0,6	0,71±0,046	11,3±2,5
Feya	0,46±0,035	27±2,0	0,44±0,006	40±3,2

Department of General Physiology, K. M. Bykov Institute of Experimental Medicine, Academy of Medical Sciences of the USSR, Leningrad. (Presented by Academician of the Academy of Medical Sciences of the USSR P. N. Veselkin.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 73, No. 3, pp. 26–28, March, 1972. Original article submitted April 26, 1971.

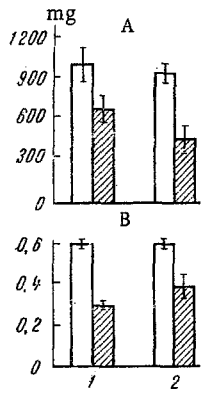

Fig. 1

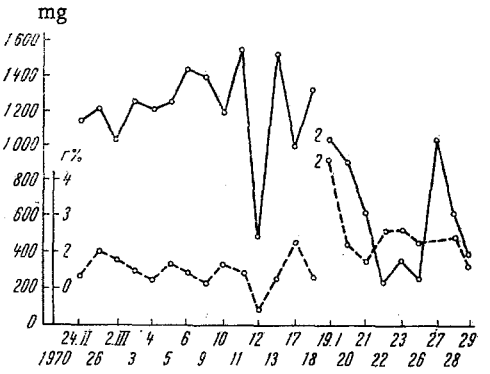

Fig. 2

Fig. 1. Loss of protein with pancreatic juice (A) and albumin-glogulin ratio of blood serum (B) in dogs with pancreatic duct exteriorized by Pavlov's method. 0) quantity of protein excreted with pancreatic juice during 3 h after food (in mg); B) albumin-globulin ratio; unshaded columns – for dogs in a satisfactory state, shaded columns – during the period of disturbed function (limits of variations of indices are shown); 1) the dog Akbar; 2) the dog Bobik.

Fig. 2. Excretion and concentration of protein 3-h portion of gastric juices of the dog Akbar after feeding. Ordinate: continuous line, protein content (in mg); broken line, protein concentration (in g%) in pancreatic juices; curve 1) dog with satisfactory pancreatic function; curve 2) pancreatic function disturbed. Abscissa, days of experiment.

function after injection of crystalline trypsin (Spofa, Czechoslovakia) dissolved in physiological saline into the pancreatic duct or into the gland tissues themselves (0.5 mg/kg body weight). The total protein, protein fractions, trypsin, and its inhibitor in the serum were determined 3 or 4 times before and 10-11 times during the 2 weeks after the procedure.

EXPERIMENTAL RESULTS

In the dogs with an exteriorized pancreatic duct the excretion of protein in the 3-h portion of juice was significantly smaller after disturbance of the pancreatic exocrine function (as revealed by changes in the blood levels of trypsin and amylase) than during the period of satisfactory pancreatic function (Fig. 1A). Meanwhile, the albumin-globulin ratio in the blood was considerably reduced (Fig. 1B). Consequently, the changes in the serum protein composition in the animals with a pancreatic fistula cannot have been due to loss of protein with the pancreatic juice.

The decrease in the quantity of protein excreted in the pancreatic juice was due to a decrease in the volume of secretion and not to a decrease in the protein concentration in the juice.

The results given in Table 1 show that the degree of decrease in the albumin-globulin ratio during a disturbance of pancreatic function does not correlate with the volume of juice lost. For instance, in the dogs Zhuchok and Bobik the decrease in this ratio was the same, wheras the loss of juice from the dog Zhuchok during the period of disturbed pancreatic exocrine function was on the average 22 ml greater, and that of the dog Bobik 48 ml less, than during the period of normal pancreatic function.

The results were confirmed in experiments in which the exocrine function of the pancreas was disturbed by injection of crystalline trypsin into its tissue or duct. Under these conditions, when loss of pancreatic juice was ruled out, the albumin-globulin ratio also fell (Fig. 3). Disturbance of the pancreatic exocrine function in the animals on which these experiments were performed was reflected in a marked increase in the blood amylase level and a decrease in the blood trypsin level.

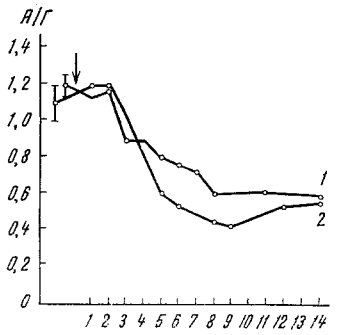

Fig. 3. Changes in albumin-globin ratio of blood serum in dogs with disturbance of pancreatic exocrine function after injection of trypsin into pancreatic duct and tissue. Ordinate, albumin-globulin ratio of blood serum from dog Dzhaz (curve 1, before and after injection of trypsin into duct) and in the dog Zhuchok (curve 2, before and after injection of trypsin into gland tissue); abscissa, days after injection of trypsin (marked by arrow).

The experimental results show that the dysproteinemia was due, not to the loss of pancreatic juice and of proteins with the juice, but to changes in the exocrine function of the gland. This conclusion is in agreement with the results obtained by Dzhakson [3], who found no negative nitrogen balance in dogs with the pancreatic duct exteriorized by Pavlov's method, and also with the work of Baltkai [2], who found dysproteinemia in dogs with a pancreatic fistula of the Solov'ev type, when the pancreatic juice entered the intestine except during the experiment.

Under normal physiological conditions the products of pancreatic exocrine activity and, in particular, amylase and trypsin, can penetrate into the blood stream [6, 8, 17, 18]. When the pancreatic exocrine function is disturbed, however, the entry of pancreatic enzymes into the blood is altered [1]. It has been shown that the pancreatic juice contains components which have nothing to do with digestion but, for example, which stimulate hematopoiesis [4], stimulate the parasympathetic nervous system [7], and affect water and mineral metabolism. It can accordingly be postulated that the reason for the change in the relative proportions of the serum protein fractions discovered in these experiments is a change in the penetration of as yet unknown components of the pancreatic juice into the blood stream.

LITERATURE CITED

1. A. A. Anoshina, N. A. Bannikova, and E. P. Fenina, Abstracts of Proceedings of the 11th Congress of the I. P. Pavlov All-Union Physiological Society [in Russian], Vol. 2, Leningrad (1970), p. 275.
2. A. A. Baltkai, Effect of Disturbance of the Pancreatic Exocrine Secretion on Hematopoiesis. Author's Abstract of Candidates Dissertation, Riga (1957).
3. I. M. Dzhakson, The Pancreatic Exocrine Function and its Role in the Regulation of Some Aspects of Metabolism. Doctoral Dissertation, Leningrad (1963).
4. I. M. Dzhakson, D. Ya. Shurygin, and O. K. Erkalova, in: Physiology and Pathology of the Endocrine System [in Russian], Khar'kov (1965), p. 157.
5. G. F. Milyushkevich, Byull. Éksperim. Biol. i Med., No. 12, 3 (1956).
6. G. F. Milyushkevich, Abstracts of Proceedings of a Scientific Conference on the Physiology and Pathology of Digestion and Absorption [in Russian], Odessa (1961), p. 155.
7. G. F. Milyushkevich, and I. A. Voronenkova, Fiziol. Zh. SSSR, No. 5, 588 (1968).
8. I. F. Spitsyn, Changes in the Proteolytic Activity of the Blood, Intestinal Juice, and Urine during Various Procedures on the Pancreas in Dogs. Authors Abstract of Candidate's Dissertation, Ivanovo (1965).

9. G. V. Troitskii, Electrophoresis of Proteins [in Russian], Khar'kov (1962).
10. S. E. Tukachinskii, in:Problems in Blood Transfusion and Clinical Medicine [in Russian], Kirov (1962), p. 64.
11. E. P. Fenina, Fiziol. Zh. SSSR, No. 1, 114 (1970).
12. E. P. Fenina, Fiziol. Zh. SSSR, No. 4, 671 (1970).
13. V. A. Shaternikov, Vopr. Med. Khimii, No. 1, 103 (1966).
14. V. Becker, Sekretionsstudien am Pankreas, Stuttgart (1957).
15. B. F. Erlanger, N. Kokowsky, and W. Cohen, Arch. Biochem., 95, 271 (1961).
16. E. Hansson, Acta Physiol. Scand., Suppl. 46, 161 (1959).
17. S. Hilton and M. M. Jones, J. Physiol. (London), 195, 521 (1968).
18. H. D. Janowitz and F. H. Hollander, Gastroenterology, 17, 591 (1951).
19. A. Vandermeers, M. C. Vandermeers-Piret, and J. Cristophe, Bull. Soc. Chim. Biol. (Paris), 49, 769 (1967).