SERUM CHOLINESTERASE ACTIVITY OF RATS WITH EXPERIMENTAL DIABETES

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A. A. Fokina

Laboratory of Endocrine Physiology (Head—Prof. E. N. Speranskaya, Corresponding Member, Academy of Medical Sciences, USSR), I. P. Pavlov Institute of Physiology, Academy of Sciences, USSR, Leningrad

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Numerous clinical and experimental observations indicate that there is a relationship between the functional state of the liver and the activity of serum cholinesterase (pseudocholinesterase), which is formed and stored in the liver. According to the data of many authors, determination of cholinesterase activity may serve as a diagnostic indication in a number of hepatic diseases [12, 17, 21, 27]. A change in the cholinesterase activity of the blood serum and certain tissues (brain and liver) may also be detected in the presence of various experimental endocrine shifts [1, 2, 7, 9]. In addition, it is well known that carbohydrate metabolism is of great importance in acetylcholine synthesis [19, 23]. A number of clinical and experimental investigations have established that administration of glucose increases cholinesterase activity [1-3, 11, 17].

We set ourselves the task of studying serum cholinesterase activity in experimental diabetes, a disease in which hepatic function is known always to be disrupted to some extent.

EXPERIMENTAL METHOD

Experimental diabetes mellitus was induced in 46 rats by removal of the pancreas and in 43 rats by administration of alloxan.

The experiments were conducted on white rats of the Wistar strain weighing 150-250 g, which received the usual laboratory diet [10].

After pancreatectomy or administration of alloxan (170-200 mg/kg) we determined the blood sugar content every 5-8 days by the Hagedorn-Jensen method; the rats were weighed every 2-3 days.

Within 5-8 days after pancreatectomy or administration of alloxan the animals exhibited external symptoms of diabetes; polyphagia, polydipsia, loss of weight, and trophic disturbances (a disshevelled coat and loss of hair). Blood sugar content was elevated on an empty stomach and to an even greater extent after eating.

Ten to twelve days after pancreatectomy or administration of alloxan all the animals were killed and their blood was taken for determination of its sugar content and cholinesterase activity. The latter was determined by the titrometric method of Zubkova and Pravdich-Nemenskaya [8] and expressed as percentage acetylcholine decomposition per unit time.

EXPERIMENTAL RESULTS

All the animals with experimental diabetes (postoperative or alloxan) were divided into 3 groups in accordance with their blood sugar content (which usually corresponded to the external symptoms of diabetes).

The 1st group comprised rats whose blood sugar content was within normal limits on the day of the experiment, although it had been at an above-normal level for the preceding 10-12 days of observation and frequently rose substantially after eating. These animals were subject to no material changes in weight.

TABLE 1. Serum Cholinesterase Activity and Blood Sugar Level of Intact and Pancreatectomized Rats

Group of rats	Serum cholinesterase activity (% acetylcholine decomposition)			Blood sugar level (mg-%)		
	M±m	n	P	M±m	n	P
Intact	12.7±0.29	46		87.0±1.52	27	
1-	14.4±0.52	23	<0.01	83.0±3.19	23	> 0.1
2-	15.1±0.76	14	<0.001	119.0±2.53	14	<0.001
3-	17.5±1.23	9	<0.001	220.0±20.63	9	<0.001

TABLE 2. Serum Cholinesterase Activity and Blood Sugar Level of Intact Rats with Alloxan Diabetes

Group of rats	Serum cholinesterase activity (% acetylcholine decomposition)			Blood sugar level (mg-%)		
	M±m	n	P	M±m	n	P
Intact	15.4±3.09	32		80.0±1.54	34	
1-	21.5±0.50	5	<0.05	93.0±1.18	5	<0.001
2-	23.0±0.70	31	<0.02	117.0±1.75	31	<0.001
3-	26.7±1.73	7	<0.01	280.0±27.20	7	<0.001

The 2nd group comprised rats with postoperative or alloxan diabetes, their blood sugar content amounting to 100-150 mg-%. This index averaged 119 mg-% in the rats with alloxan diabetes. The majority of the animals in this group displayed polyphagia, polydipsia, and a loss of weight amounting to 6%.

In the rats of the 3rd group blood sugar content fluctuated between 150 and 300 mg-%. The blood sugar level of the pancreatectomized rats averaged 220 mg-%, while that of the rats with alloxan diabetes averaged 280 mg-%. All the animals exhibited polyphagia, polydipsia, trophic disturbances, and a loss of weight amounting to 10%. The mean serum cholinesterase activity of the control rats amounted to an acetylcholine decomposition of 12.7%.

Cholinesterase activity was higher in all 3 groups of animals with postoperative diabetes (the experiments were conducted during the autumn and winter) than in the control animals (Table 1); it was found that the magnitude of this difference depended on the severity of the diabetic disturbances. The increase in cholinesterase activity was most marked in the animals with higher blood sugar contents.

An investigation of 32 intact rats and 43 rats with alloxan diabetes was conducted during the autumn and this might have affected serum cholinesterase activity. Cholinesterase activity proved to be greater in these animals than in those with postoperative diabetes, averaging 15.4% acetylcholine decomposition for intact rats.

In all 3 groups serum cholinesterase activity was also higher in the rats with alloxan diabetes (Table 2).

The data obtained are in agreement with the results of clinical investigations, in which an increase in serum cholinesterase activity was noted in diabetes mellitus patients [18, 20, 22, 25, and 26], as well as with experimental data indicating that serum cholinesterase activity is elevated in alloxan diabetes [24].

It must be noted that D. I. Malkina and Kh. S. Khamitov [13] noted a decrease in serum cholinesterase activity after partial pancreatectomy and transection of the pancreatic ducts, but they were unable to detect any change in blood sugar level.

The increase in serum cholinesterase activity in diabetes detected in our investigations may result from a disruption of carbohydrate metabolism, but we cannot exclude the possibility that a disruption of lipid metasolism also plays some part. Certain investigators have noted that cholinesterase activity increases when lipid metabolism is disrupted [22, 25, 26].

SUMMARY

A study was made of the cholinesterase activity of blood serum in intact rats (78) and in rats with induced

diabetes (following pancreatectomy—in 46 rats, following alloxan administration, 43 rats). The blood serum cholinesterase activity increased both in induced, postoperative, and alloxan diabetes. There was a relationship between the increase in the cholinesterase blood serum activity and the severity of diabetic disturbances. The greater the blood sugar level the higher was cholinesterase activity.

LITERATURE CITED

1. N. F. Baranova. Abstracts of Papers Presented at A Conference on the Role of Neurohumoral and Endocrine Factors in Nervous Activity under Normal and Pathological Conditions [in Russian], Leningrad (1957), p. 7.
2. N. F. Baranova. In book: Scientific Reports of the Institute of Physiology [in Russian], Moscow-Leningrad (1959), No. 1, p. 89.
3. N. F. Baranova and M. I. Mityushov. Cited by M. I. Mityushov.
4. N. V. Veselkin, V. V. Savich, and V. M. Sudakova-Veselkina. Izv. Nauchnogo ist. fizicheskoi kul'tury im. Lesgafta (1922), Vol. 5, p. 57, 117.
5. S. G. Genes, Diabetes Mellitus [in Russian], Moscow (1963).
6. M. M. Gubergrits, Klin. med. (1934), Vol. 12, No. 7, p. 1127.
7. I. M. Jackson. Byull. éksper. biol. (1947), Vol. 23, No. 5, p. 367.
8. S. R. Zubkova and T. V. Pravdich-Neminskaya. In book: Collection of Abstracts of Scientific Works for 1945 [in Russian], AN SSSR, Otd. biol. nauk. (1947), p. 353.
9. E. A. Kakushkina and T. T. Tatarko, Byull. éksper. biol. (1942), Vol. 13, No. 1-2, p. 14.
10. K. L. Kovalevskii. Raising Laboratory Animals [in Russian], Moscow (1958).
11. A. V. Koval'chuk. Vopr. pitaniya (1961), No. 6, p. 28.
12. M. P. Kuz'minykh. Kazansk. med. zh. (1960), No. 1, p. 26.
13. D. I. Malkina and Kh. S. Khamitov. Fiziol. zh. SSSR (1960), No. 5, p. 565.
14. M. I. Mityushov. Excitability of the Peripheral Apparatus of the Autonomic Cardiac Fibers and Blood Sugar Level. Author's Abstract of Candidate's Dissertation [in Russian], Leningrad (1950).
15. I. M. Sokoloverova. Experimental Data on the Pathogenesis of the Age-Linked Characteristics of Diabetes Mellitus. Author's Abstract of Candidate's Dissertation [in Russian], Leningrad (1963).
16. E. N. Speranskaya. Fiziol. zh. SSSR (1940), No. 4, p. 334.
17. E. P. Shuvalova. Uchen. zapiski 1-go Leningradsk. med. inst. (1959), Vol. 3, p. 441.
18. W. Antopol, L. Tuchman, and A. Schifrin. Proc. Soc. exp. Biol. (N. Y.) (1937), v. 36, p. 46.
19. G. Kahlson and F. C. McIntosh. J. Physiol. (Lond.) (1939), v. 96, p. 277.
20. A. Kaswin. Presse méd. (1945), v. 53, p. 713.
21. R. G. O. Kekwick. Biochem. J. (1960), v. 76, p. 120.
22. A. M. Pelocchino, C. Prinotti, and G. Rigazio. Arch. Sci. med. (1960), v. 110, p. 451.
23. J. H. Quastel and D. M. J. Quastel. The Chemistry of Brain Metabolism in Health and Disease. Springfield (1961).
24. M. Saviano, R. Ballbi, and De Franciscus. cited in R. H. S. Thompson and J. R. Trounce.
25. E. Strehler and H. Meyer. Helv. med. Acta. (1952), v. 19, p. 555.
26. R. H. S. Thompson and J. R. Trounce. Lancet (1956), v. 1, p. 656.
27. L. J. Vorhaus, H. H. Scudamore, and R. M. Kark. Am. J. med. Sci. (1951), v. 221, p. 140.

All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
