CHANGES IN LIVER AND SKELETAL MUSCLE METABOLISM DURING PARENTERAL FEEDING

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The content of nucleic acids and of readily extracted protein in the liver and skeletal muscle was investigated in rats with alloxan diabetes fed parenterally with various protein digests. Administration of these sources of nitrogen was shown to activate nucleic acid metabolism and thus to promote the restoration of protein metabolism.

KEY WORDS: alloxan diabetes; parenteral feeding; nucleic acid and protein metabolism.

The following principles governed the writers' approach to the experimental analysis of parenteral feeding: 1) all processes during parenteral feeding take place at the tissue level, and the work is thus best done on tissue test objects; 2) the study of certain aspects of this problem on special biological models, similar in their pathogenesis to the functional disturbances actually observed in patients receiving parenteral feeding in hospital, is particularly interesting [3]. The writers have shown that parenteral feeding with protein digests improves nucleic acid metabolism in the liver in experimental hepatitis even though the nitrogen balance of the animals still remains negative [1, 2].

In the present investigation the effect of various protein digests prepared for parenteral feeding on certain aspects of liver and skeletal muscle metabolism was studied after interference with the function of the endocrine part of the pancreas.

EXPERIMENTAL METHOD

Alloxan diabetes was used as the experimental pathological model. Insufficiency of the insular system was induced by two subcutaneous injections of 5% alloxan solution (10 mg/100 g body weight) at an interval of 5-7 days. On the 14th day after the first injection of alloxan, with the animals on a protein-free diet, subcutaneous injections of casein hydrolysate, a solution of Hydrolysin L-103, Aminozol, and the amino-acid mixture Moriamine S-2 were given for 8 days. The nitrogen sources were injected in a dose of 0.3 g conventional protein/100 g body weight. Rats with alloxan diabetes kept on a protein-free diet throughout the experimental period and intact animals kept under the ordinary conditions of the animal house were used as the controls. Each series consisted of 8-12 rats weighing 200-280 g.

The concentrations of nucleic acids in all the rats were studied spectrophotometrically [6]; for skeletal muscle the coefficient of molar uptake of nucleic acids suggested by Silakova and Polishchuk [5] and the readily extracted protein [7] were determined for skeletal muscle.

EXPERIMENTAL RESULTS

In rats with alloxan diabetes (Table 1) the total RNA concentration was reduced, especially in skeletal muscle. After administration of casein hydrolysate the RNA content in the muscle was unchanged, but in the liver it was significantly increased. A solution of Hydrolysin L-103 caused a sharp increase in the RNA content in the muscle and liver compared not only with the control but also with the intact animals. Aminozol and Moriamine S-2 restored the normal RNA concentration in the muscle and liver.

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TABLE 1. Effect of Protein Digests on Nucleic Acid and Readily Extracted Protein Concentration in Liver and Skeletal Muscle in Rats with Alloxan Diabetes (M ± m)

Group of animals	Liver			Skeletal muscle		
	RNA (mg P/100 g tissue)	DNA (mg P/100 g tissue)	protein (mg/g tissue)	RNA (mg P/100 g tissue)	DNA (mg P/100 g tissue)	protein (mg/g tissue)
Alloxan diabetes (control)	31,1±1,6	17,8±1,2†	138,8±8,7†	8,6±0,7†	5,8±0,6	62,1±4,2†
Alloxan diabetes + casein hydrolysate	41,6±1,9*	13,8±1,1†	161,0±10,2	7,3±0,2†	5,3±0,1†	73,5±2,9
Alloxan diabetes + Hydrolysin L-103 solution	65,6±2,6*†	40,5±3,1*	146,6±6,7†	16,7±1,3*	11,6±0,7*	70,6±2,4†
Alloxan diabetes + Aminozol	55,9±5,9*	29,1±2,9*	113,0±3,8†	10,4±0,3†	5,3±0,5	64,4±1,9†
Alloxan diabetes + Moriamine S-2	50,4±3,3*	31,9±2,5*	135,0±10,2†	13,2±1,4*	4,9±0,8†	72,2±3,5*
Intact	39,7±1,2	28,7±4,6	173,0±10,9	12,2±1,0	9,1±2,1	80,7±4,3

*P < 0.05 compared with control.

†P < 0.05 compared with intact rats.

Determination of DNA showed a significant decrease in its content in the liver in alloxan diabetes, in agreement with data in the literature [4]. After administration of casein hydrolysate the DNA concentration in the liver fell even more, but in the muscle it was unchanged. Hydrolysin L-103 solution increased the DNA level in both muscle and liver, but Aminozol and Moriamine S-2 increased it in the liver only.

The content of readily extracted tissue protein in the rats with alloxan diabetes was significantly reduced both in the liver and muscle compared with the intact control. It was only slightly increased in the muscle and unchanged in the liver as a result of administration of the digests.

The protein digests, when given to rats with insufficiency of the insular system, altered the ratio between RNA and DNA in the liver and skeletal muscle, mainly on account of an increase in the RNA content. Casein hydrolysate increased the RNA/DNA ratio in the liver to 2.8, whereas in muscle this ratio was increased after administration of Aminozol and Moriamine S-2. The ratio between RNA, DNA, and protein also was altered, especially after administration of Hydrolysin L-103, Aminozol, and Moriamine S-2. The increase in the DNA concentration in the liver of the rats with alloxan diabetes after administration of the digests was evidently due to the improvement in regeneration of the liver cells, associated with enlargement of the nuclei.

Administration of protein digests to animals with experimental diabetes thus activates nucleic acid metabolism and promotes recovery of protein metabolism. Besides an improvement in tissue metabolism in these animals, their loss of body weight was reduced and in the case of Moriamine S-2 the weight of the rats remained unchanged. The effectiveness of parenteral feeding in this pathological condition was demonstrated by the increase in the negative nitrogen balance (Hydrolysin L-103 and casein hydrolysate) or its reversal to positive (Aminozol, Moriamine S-2).

LITERATURE CITED

1. R. M. Glants and E. V. Skovronskaya, Vopr. Pitaniya, No. 3, 17 (1973).
2. R. M. Glants and R. A. Krivoruchko, Probl. Gematol., No. 7, 59 (1973).
3. Yu. M. Orlenko, R. M. Glants, and F. F. Usikov, Khirurgiya, No. 2, 111 (1970).
4. N. P. Sayuk, Ukr. Biokhim. Zh., No. 1, 73 (1972).
5. A. I. Silakova and S. M. Polishchuk, Ukr. Biokhim. Zh., No. 3, 318 (1969).
6. R. G. Tsanev and G. G. Markov, Biokhimiya, 25, 151 (1960).
7. O. H. Lowry, N. S. Rosebrough, A. L. Farr, et al., J. Biol. Chem., 193, 265 (1951).