Protective Effect of Taurine on Rats with Experimental Insulin-Dependent Diabetes Mellitus

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Taurine had the hypoglycemic effect during experimental insulin-dependent diabetes mellitus and decreased the concentrations of glucose and fructosamine, and increased the contents of insulin, C-peptide, and glycogen in the liver. Studying the dynamics of structural changes in pancreatic tissue confirmed a positive effect of taurine on β-cell function. The protective effect of taurine manifested in the absence of morphological signs for alloxan-induced diabetes: decrease in the number and size of pancreatic islets, change in their distribution, reduction of β-cell count, and accumulation of homogeneous deposits in islets.

Key Words: *insulin-dependent diabetes mellitus; hypoglycemic and protective effect of taurine*

Insulin-dependent diabetes mellitus (IDDM) is associated with β-cell injury in pancreatic islets. Insulin deficiency in IDDM leads to hyperglycemia and severe metabolic disorders [1,3].

Here we studied the protective effect of taurine on rats with alloxan-induced IDDM. Parameters of carbohydrate metabolism and morphological changes in the pancreas were evaluated rats with IDDM treated with taurine.

MATERIALS AND METHODS

Experiments were performed on male outbred albino rats (n=110) weighing 220-250 g. The animals were divided into 3 groups. Group 1 consisted of intact rats. Control group 2 included rats with alloxan-induced diabetes receiving no therapy. Group 3 comprised rats with IDDM treated with taurine. IDDM was induced by subcutaneous injection of alloxan monohydrate in a single dose of 100 mg/kg (Sigma). This agent causes β-cell injury in pancreatic islets. Taurine (750 mg/kg) was given *per os* for 21 days. The concentrations of glucose and fructosamine in blood plasma were measured spectrophotometrically using standard reagents. The contents of insulin and C-peptide in blood plasma were estimated by enzyme immunoassay with standard reagents. Glycogen content in the liver was measured routinely.

For histological study, the pancreas was fixed in 10% formalin. Morphological study of the pancreatic body and tail was performed on paraffin sections after staining with hematoxylin and eosin. The samples were photographed at ×200. The results were analyzed by Student's t test (Statgraphics 6.0 software).

RESULTS

The rats with experimental IDDM were characterized by body weight loss and increase in water consumption and daily diuresis. The animals were behaviorally inactive and looked untidily. Mortality

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rate of animals not receiving taurine reached 50%. We revealed an increase in the concentrations of glucose and fructosamine, decrease in the contents of insulin and C-peptide, and glycogen depletion in the liver (Table 1). Morphological signs for alloxan-induced diabetes were found on days 3-7 and

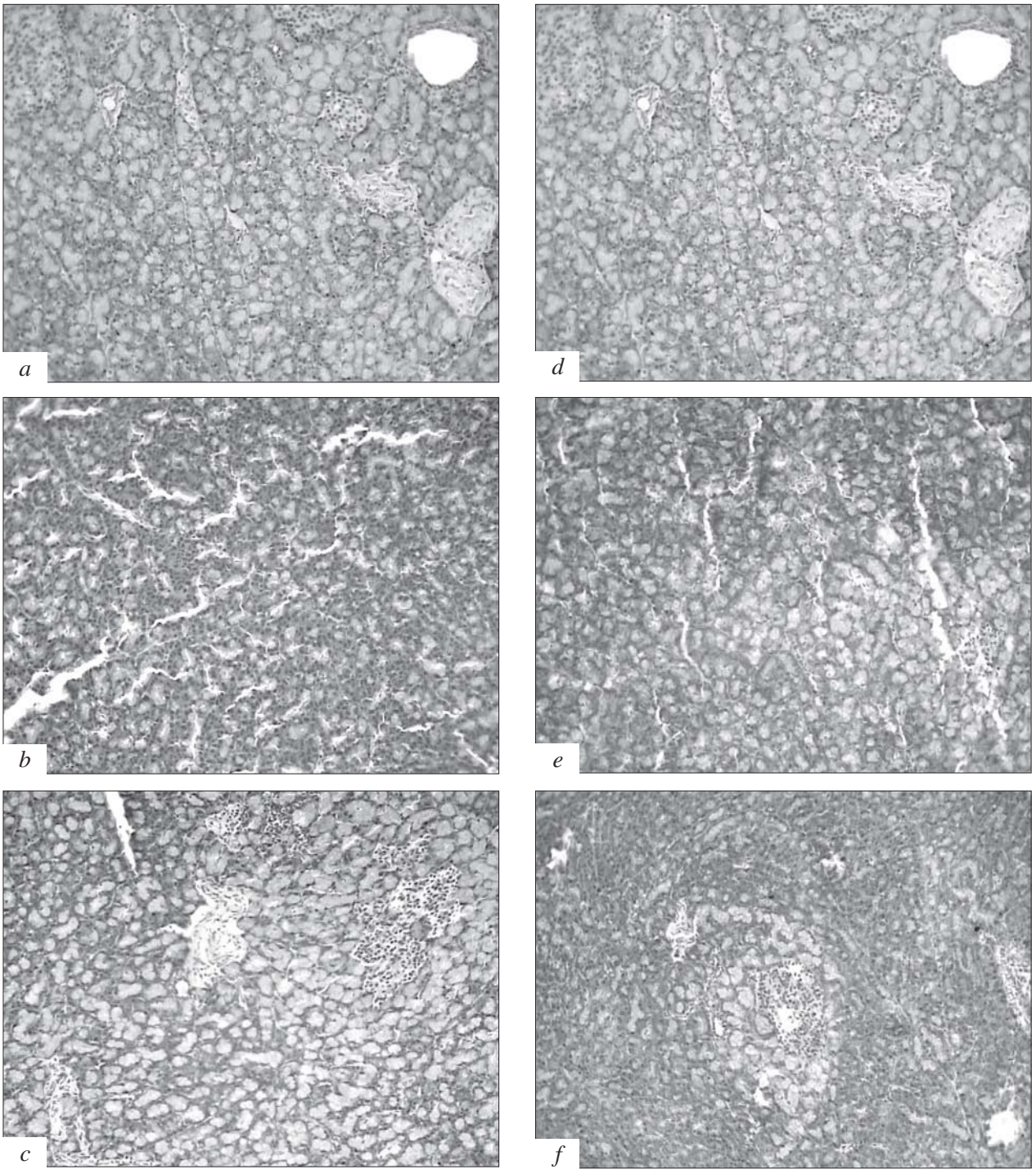

Fig. 1. Effect of taurine on structural changes in the pancreas of rats with experimental IDDM. (*a-c*) Day 7 of IDDM; (*d-f*) day 21 of IDMM. (*a*, *d*) Intact group. Pancreatic islets of similar size and shape are regularly distributed in the central and peripheral region of β-cells. (*b*) Control group. Absence of pancreatic islets. The number of β-cells is sharply reduced. β-Cells are arranged in small groups. Severe dystrophy of the exocrine part. (*c*) Treatment group, taurine therapy. Pancreatic islets of different size. Irregular distribution of β-cells in the peripheral region. (*e*) Control group. Numerous small groups of β-cells that are not arranged in islets. Focal degeneration and necrobiosis in exocrine structures. (*f*) Treatment group, taurine therapy. Large pancreatic islets, considerable number of β-cells. Focal degeneration of the epithelium in exocrine structures.

TABLE 1. Protective Effect of Taurine on Several Physiological and Metabolic Parameters in Rats with Experimental IDDM (*M*±*m*)

Parameter	Group 1, *n*=25	Alloxan-induced diabetes	
		group 2, *n*=25	group 3, *n*=25
Survived animals, %	100	50	70
Body weight, g	273.7±4.7	233.0±6.2*	256.0±6.2
Water consumption, ml/day	18.0±2.0	58.0±8.7*	23.0±3.6+
Daily diuresis, ml/day	4.0±0.1	40.0±3.1*	6.0±0.1+
Specific weight, g/ml	1.018±0.001	1.009±0.001*	1.018±0.001+
Glucose, mmol/liter	3.22±0.08	10.34± 0.92*	3.69±0.12+
Fructosamine, mmol/liter	1.35±0.12	3.55±0.20*	1.59±0.21+
Liver glycogen, μg/mg	14.71±0.58	3.22±0.13*	5.46±0.18*+
Insulin, pmol/liter	68.56±1.57	21.23±0.74*	56.03±2.78+
C-peptide, ng/ml	1.06±0.09	0.37±0.03*	1.40±0.08+

Note. $p \leq 0.05$: *compared to group 1; +compared to group 2.

considerably progressed by the 21st day (Fig. 1). They included a decrease in the number and size of pancreatic islets, their abnormal distribution in the pancreatic body and tail, significant and progressive decrease in the number of β-cells, cell pyknosis, accumulation of homogeneous deposits in islets, focal degeneration and necrobiosis in exocrine structures (days 7 and 21), mild compensatory and adaptive hyperplasia of islets, sclerotic changes in intraorgan vessels, and initial stages of interlobular and intralobular sclerosis (Fig. 1, *b*, *e*). Administration of alloxan caused the symptom complex, which was similar to that in humans [2].

Administration of taurine prevented the development of alloxan-induced changes. Taurine decreased the concentrations of glucose and fructosamine by 64.3 and 55.2%, respectively. The content of liver glycogen and concentration of plasma insulin and C-peptide in taurine-receiving rats were much higher than in control animals (Table 1). Hence, taurine improves carbohydrate metabolism and production of insulin and C-peptide. Hypoglycemic activity of taurine is manifested in activation of compensatory and adaptive processes in the pancreas of animals with IDDM. Analysis of the dynamics of structural changes in pancreatic tissue confirmed the positive effect of taurine on β-cell function. Histological study showed that the protective effect of taurine manifested in the absence of morphological signs for alloxan-induced diabetes on day 21. The state of β-cells returned to normal in this period. These cells were regularly distributed and prevailed over α-cells (Fig. 1, *f*). The effect of taurine is probably related to membrane-protective properties in various diseases [4-6].

The results of biochemical and morphological studies indicate that taurine is a potent hypoglycemic drug, which has a protective and normalizing effect on pancreatic β-cells. These data indicate that taurine holds much promise for combined therapy of diabetes mellitus.

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