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EFFECT OF GLUCOSE ON SERUM ELECTROLYTES AND OSMOLALITY: STUDIES IN RATS

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The effects of glucose on serum electrolytes and osmolality were studied in rats. Rats were injected glucose (70mg/100g) intraperitoneally. One hr. after injection blood was analyzed for serum electrolytes and osmolality. Administration of glucose caused increase in serum sodium and decrease in serum potassium, calcium, magnesium, phosphorus and osmolality. These results suggested that ingestion of glucose alters both serum electrolytes and osmolality in rats.

Key words: Glucose, Electrolytes, Osmolality

Introduction

Our previous studies have shown that administration of certain drugs causes and alteration in serum electrolytes which was of major importance in the interpretation of clinical data [17,18]. Administration of glucose is a common practice, however, little information is available regarding the effect of glucose administration on serum electrolytes. Studies have shown that the ingestion of glucose or other carbohydrate and proteins augments the rate of excretion of calcium and magnesium [1]. A decline in serum calcium, magnesium and phosphorus was observed after oral ingestion of glucose in adults [2] and children [13,14]. The present study was undertaken to evaluate the action of intraperitoneal administration of glucose on serum sodium, potassium, calcium, chloride, magnesium, phosphorus and osmolality in rats.

Experimental

One year old male wistar albino rats (180-250 g body weight N=20) were taken for the study. Animals were kept in the animal room on a standard diet (prepared in our laboratory) and water prior to the experiment and were divided randomly in two groups named as control and test.

Test groups were injected D-glucose (70 mg/100g, 50% w/v in deionized water intraperitoneally). Control groups received an equal volume of deionized water through the same route.

One hr. after injection, animals were decapitated blood samples were collected and serum was analyzed for concentration of sodium, potassium and calcium by flame photometer (Corning-400), serum chloride by the method of Schales and Schales [4], serum magnesium by the procedure of Hallry and Peck [5], serum phosphorus by the method of Gomorri [6], serum glucose by the method of Hultman and Hartle [7,8] and serum osmolality was measured in terms of mOsm/kg by using a Knauer-Semi-Micro Osmometer.

Statistics: Results are presented as mean ±S.E. Statistical significance of the difference of control and test values was evaluated by unpaired student's 't' test. [16]

Results and Discussion

The results (Table 1) indicate a slight elevation in serum sodium where as serum potassium, calcium, chloride, magnesium and phosphorus decrease after intraperitoneal administration of glucose.

Increased concentration of serum sodium after the glucose administration might be due to the increased re-absorption. After the administration of glucose hyper-glycaemia will be developed. It is conceivable that in the process of re-absorption of glucose the tubular cells re-absorb sodium simultaneously producing antinatriuresis, as a result of which serum sodium slightly gets elevated [9-11].

TABLE 1. EFFECT OF INTRAPERITONEAL ADMINISTRATION OF GLUCOSE (70 mg/100g) ON SERUM SODIUM, POTASSIUM, CALCIUM, CHLORIDE, MAGNESIUM, PHOSPHORUS AND OSMOLALITY IN RATS VALUES ARE MEAN ± S.E. OF 10 ANIMALS.

	Control	Glucose injected	%change	P-value
Serum sodium (mEq/L)	137.40±0.21	139.0±0.43	1.16% increase	<0.05
Serum potassium (mEq/L)	5.78±0.20	5.24±0.23	9.34% decrease	<0.01
Serum calcium (mEq/L)	5.63±0.22	4.83±0.19	14.2% decrease	<0.05
Serum chloride (mEq/L)	113.59±3.02	97.89±1.06	13.8% decrease	<0.01
Serum magnesium (mEq/L	2.78±0.19	2.13±0.31	23.3% decrease	<0.05
Serum phosph. (mEq/L)	3.36±0.18	2.40±0.17	28.5% decrease	<0.05
Serum glucose (mg/dL)	112.59±3.01	149.02±2.75	32.3% increase	<0.001
Serum osmolality (mOsm/kg)	304.±5.89	299.±7.12	1.6% decrease	<0.05

Our data show a fall in the serum potassium after glucose administration (Table 1). This hypokalemia may be explained by two mechanisms: (i). The administration of glucose is accompanied by movement of potassium into cells as glucose is utilized [12]. (ii) Glucose administration increases potassium excretion and expands extracellular fluid volume.

Very little information is available regarding the effect of glucose on serum calcium, magnesium and phosphorus levels. However some workers have reported an increased excretion of these divalent ions after glucose injection [1,10,13]. A possible explanation for the lowered serum Ca, Mg, and Phosphorus noted after glucose load may be the involvement of these ions in cellular metabolism. Glucose metabolism is associated with intracellular shifts in calcium and magnesium. The fall in serum phosphorus may be related to the role of phosphorylation in cellular glucose utilization [13].

Apart from the involvement of these ions in cellular metabolism and resulting hypocalcaemia, hypomagnesaemia and hypophosphataemia after glucose ingestion, some previous studies also show a reduction in the renal tubular re-absorption of calcium, magnesium and phosphorus after glucose administration [14]. The reduced re-absorption of these divalent ions after glucose administration might be a possible cause of the decreased serum levels.

The present study suggest that ingestion of glucose alters both serum electrolytes and Osmolality in rats. Our findings, if extended to human beings, may be of special clinical relevance in monitoring the care of patients having low serum sodium, potassium, calcium, magnesium or phosphorus levels.

Alterations in the serum electrolytes and osmolality may influence the interpretation of clinical data in patients with oral or parenteral administration of glucose.

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