EFFECT OF PROLONGED THYROCALCITONIN ADMINISTRATION ON ELECTROLYTE METABOLISM DURING NORMAL AND RESTRICTED MOVEMENT

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The effect of thyrocalcitonin (TCT) on the excretion of sodium, potassium, calcium, and magnesium by the kidneys and gastrointestinal tract was studied in 76 male rabbits under conditions of free and restricted movement. Prolonged administration of TCT to both groups of rabbits caused an equal increase in the total potassium excretion, a decrease in the magnesium excretion, and no effect on sodium excretion. The total loss of calcium from the body during hypokinesia and TCT administration was much less than during hypokinesia alone.

The thyroid hormone thyrocalcitonin (TCT) not only affects calcium metabolism, as was hitherto believed [4], but also helps to regulate the water, sodium, potassium, and magnesium balance [2, 3]. The conflicting evidence of the effect of TCT on electrolyte metabolism can evidently be explained by the species specificity of the hormone and the nature of the test object. In some investigations, moreover, the role of the intestine in the regulation of the electrolyte balance and the initial state of the animal were disregarded.

The object of this investigation was to study the effect of TCT on sodium, potassium, calcium, and magnesium excretion by the kidneys and gastrointestinal tract of rabbits under conditions of free and restricted (hypokinesia) movement.

EXPERIMENTAL METHOD

For these experiments 76 male chinchilla rabbits initially weighing 2500 g were divided into four groups: 1) control; 2) hypokinesia; 3) receiving TCT; 4) hypokinesia + TCT. Hypokinesia for 30 days was produced by keeping the animals in special constraining cages. The TCT used was obtained from bovine thyroid glands; its activity was 300 units/mg [1]. The TCT was injected subcutaneously into the rabbits of groups 3 and 4 twice a day throughout the period of the experiment in a dose of 50 units per injection. The animals received a standard pellet diet with the addition of hay and vegetables. Water was given ad lib. The concentrations of sodium, potassium (by flame photometry), magnesium (by atomic absorptiometry), and calcium (by photoelectric colorimetric titration using murexide as indicator) in the blood plasma of the rabbits were determined before taking food on the 2nd, 8th, 15th, 22nd, and 30th days. The electrolytes also were determined in the 24-hour specimens of urine and feces (by atomic absorptiometry.)

EXPERIMENTAL RESULTS AND DISCUSSION

Throughout the experiment the plasma calcium concentration of the control rabbits fluctuated between 6.29 and 8.06 meq/liter; it was low after 8 and 15 days of hypokinesia (by 6 and 14%, respectively) but at other times it was the same as in the control. Administration of TCT lowered the plasma calcium concentration in the freely moving rabbits on the 8th day (16% of the control; $P < 0.001$) and on the 8th and 15th days

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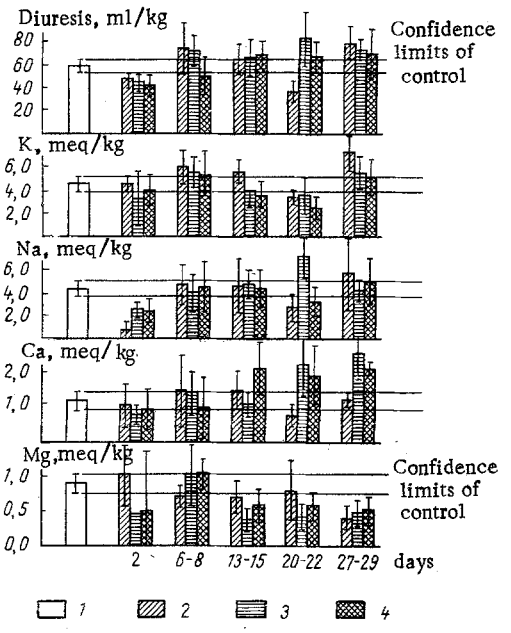

Fig. 1

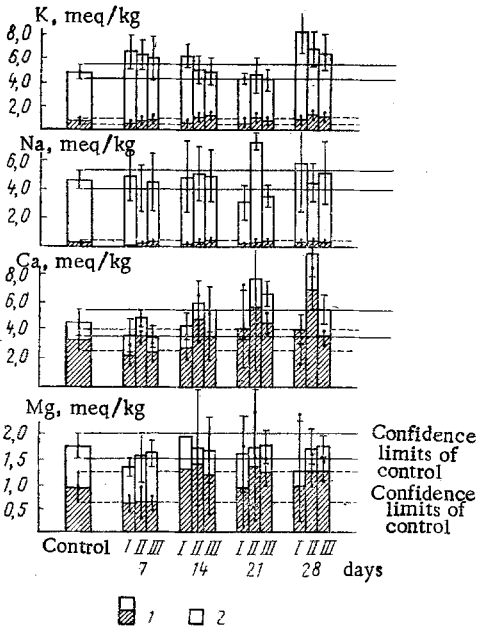

Fig. 2

Fig. 1. Diuresis and excretion of electrolytes in the urine during hypokinesia and administration of thyrocalcitonin (calculated per kg body weight): 1) control; 2) thyrocalcitonin; 3) hypokinesia; 4) hypokinesia + thyrocalcitonin.

Fig. 2. Excretion of electrolytes in the urine and feces during hypokinesia and administration of thyrocalcitonin (expressed per kg body weight): 1) total excretion of electrolytes; 2) excretion of electrolytes in the feces. I) Thyrocalcitonin; II) hypokinesia; III) hypokinesia + thyrocalcitonin.

of hypokinesia (by 6 and 8%, respectively; $P < 0.05$).

The magnesium concentration in the plasma during hypokinesia was indistinguishable from that in the control and it ranged from 1.13 to 1.78 meq/liter. After injection of TCT into the rabbits of group 3 the plasma magnesium concentration was significantly increased on the 8th, 15th, and 22nd days (by 23, 21, and 18%, respectively). In the rabbits of group 4 the plasma magnesium concentration also was increased: by 11% after 8 days and by 34% after 15 days ($P > 0.05$).

In the animals of all groups the plasma sodium concentration varied from 141 to 150 meq/liter. At no time of the investigation were significant differences from the control observed. During hypokinesia the calcium excretion in the urine was reduced on the second day to 74% of the control (Fig. 1; $P < 0.05$), it was indistinguishable from the control on the 7th and 14th days, and sharply increased on the 21st and 28th days (189 and 216% of the control; $P < 0.05$). The magnesium excretion in the urine was considerably reduced almost throughout the experiment, to 40, 44, and 53% of the control on the 14th, 21st, and 28th days, respectively ($P < 0.05$). Hypokinesia had no effect on the urinary excretion of potassium, but the sodium excretion followed a wave-like course: it fell considerably on the 2nd day of the experiment (57% of the control; $P < 0.001$), was at the control level on the 14th day, was increased on the 21st day (158% of the control; $P < 0.05$), and was back to normal again on the 28th day.

Under the influence of TCT a decrease in the calcium excretion in the urine of the unrestrained animals was observed only on the 21st day (55% of the control; $P < 0.01$); the magnesium excretion fell starting on the 7th day of the experiment, to reach 39% of the control level on the 28th day ($P < 0.001$). The potassium excretion in the urine of the rabbits of group 3 was increased on the 7th, 14th, and 28th days (141, 132, and 172%, respectively; $P < 0.01$); the sodium excretion was unchanged at these times, but on the 2nd and 21st days it fell to 18 and 64% of the control ($P < 0.001$ and < 0.05).

The calcium excretion in the urine of the rabbits with restricted movement was reduced on the 2nd and 7th days after administration of TCT and increased on the 14th, 21st, and 28th days of the experiment. However, the increase in the calcium excretion was less marked than in the animals with hypokinesia

alone: 11% after 21 days and 17% after 28 days. The magnesium excretion in the urine of the rabbits of group 4 was reduced by about the same degree as in the rabbits of groups 2 and 3. TCT, while increasing the urinary excretion of potassium in the rabbits of group 3, had no such action on the animals with restricted movement. Changes in the sodium excretion in rabbits receiving TCT during the period of hypokinesia corresponded to those in the animals of group 3: the sodium excretion in the rabbits of group 4 was reduced on the 2nd day (54% of the control; $P < 0.01$), it returned to normal on the 7th and 14th days, fell on the 21st day (72%; $P < 0.01$), and reached the control level on the 28th day of hypokinesia.

The study of the excretion of electrolytes in the feces of the control rabbits showed that about 70% of the total excretable calcium is eliminated via the gastrointestinal tract; magnesium is excreted about equally in the urine and feces, and most of the sodium and potassium is excreted in the urine.

To investigate the effect of these factors on electrolyte metabolism in the course of the experiment, the calcium, magnesium, potassium, and sodium concentrations were determined in the urine and feces together. In hypokinesia the calcium excretion in the urine and feces rose progressively (Fig. 2): by 10% after 7 days, 32% after 14 days, 74% after 21 days, and 111% after 28 days compared with the control ($P < 0.05$ after 21 and 28 days). The combined excretion of magnesium remained unchanged; sodium excretion was increased on the 21st day ($P < 0.001$) and potassium excretion, on the 28th day of hypokinesia ($P < 0.05$).

Administration of TCT (group 3) led to a decrease in the calcium and magnesium excretion on the 7th (81 and 75% of the control, respectively) and 28th days (88 and 71%). The sodium excretion was unchanged but the potassium excretion was increased to 164% of the control.

The increase in the calcium excretion in the urine and feces of the rabbits of group 4 took place later and was more marked than in the animals with hypokinesia alone. The effect was particularly great on the 28th day when the calcium excretion in the rabbits of group 4 was reduced to almost half that in the animals of group 2. The excretion of magnesium, potassium, and sodium was the same in the rabbits of groups 3 and 4.

These results thus showed that prolonged administration of TCT both to unrestrained rabbits and to rabbits kept in hypokinesia causes an equal increase in the total potassium excretion, a decrease in the magnesium excretion, but has no effect on the sodium excretion. Total loss of calcium from animals in hypokinesia and receiving TCT was much less than in rabbits with hypokinesia alone.

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