# EFFECT OF INSULIN ON TUBULAR SECRETION

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UDC 612.465.2.014.46 : 615.357.37

Insulin increases the rate of maximal tubular secretion and the accumulation of diodone by slices of renal cortex of dogs and rabbits. This effect is accompanied by a reduction in diuresis and in sodium and potassium excretion.

Investigations [1, 3, 5, 6] have shown that insulin modifies diuresis. The effect of insulin on the secretory function of the kidneys is not discussed in the literature and the investigation described below was carried out to fill this gap.

## EXPERIMENTAL METHOD

Acute experiments were carried out on dogs and rabbits. In 14 dogs anesthetized with Nembutal the abdomen was opened with a small incision and polyethylene catheters introduced into the ureters. The urine was collected every 10 min. The rate of maximal tubular secretion was determined by Smith's method during continuous infusion of diodone. Insulin, in a dose of 1 unit/kg body weight, was injected intravenously. In some experiments insulin in a dose of 0.1-0.2 unit/min was injected into the left renal artery. By carrying out the experiment in this way, indirect effects could be excluded, and the direct action of insulin on the tubular epithelium of the kidneys revealed. The effect of insulin on accumulation of diodone by slices of the renal cortex was studied in 64 experiments. In series I (32 experiments) insulin was added to the incubation medium in a dose of 0.0025 unit/ml, and in series II insulin in a dose of 1.5 unit/kg was injected intravenously into the animals 30 min before removal of the kidneys. Diodone was determined by the method of Bak et al. [5]. Besides determination of the secretion, the diuresis, the filtration-reabsorption function of the kidneys, and the excretion of electrolytes were investigated in acute experiments on dogs. All indices were expressed per animal. The numerical results were analyzed by statistical methods.

## EXPERIMENTAL RESULTS AND DISCUSSION

The results of the acute experiments on dogs showed that insulin substantially increased the rate of maximal tubular secretion of diodone (Table 1).

TABLE 1. Effect of Intravenous Injection of Insulin on Rate of Maximal Tubular Secretion, Diuresis, Filtration, and Reabsorption in Dogs (M±m)

| Index | Before injection of insulin | 30 min after injection of insulin | P |
|---|---|---|---|
| Maximal secretion of diodone (in mg/min) | 28.7±1.4 | 33.8±1.1 | < 0.05 |
| Diuresis (in ml/min) | 0.76±0.08 | 0.54±0.11 | < 0.001 |
| Filtration (in ml/min) | 18.6±0.82 | 19.2±0.73 | < 0.5 |
| Reabsorption (in %) | 95.37±0.14 | 97.2±0.26 | < 0.001 |

Department of Pharmacology, Altai Medical Institute, Barnaul. (Presented by Academician of the Academy of Medical Sciences of the USSR, V. V. Zakusov.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 72, No. 12, pp. 13-15, December, 1970. Original article submitted September 7, 1970.

TABLE 2. Effect of Insulin, Injected into the Renal Artery, on Kidney Function (M±m)

| Index | Before injection of insulin | During injection of insulin | P |
|---|---|---|---|
| Maximal secretion of diodone (in mg/min) | 16.6±2.1 | 23.1±1.8 | < 0.05 |
| Diuresis (in ml/min) | 0.51±0.04 | 0.32±0.05 | < 0.01 |
| Filtration (in ml/min) | 9.6±0.41 | 9.4±0.28 | < 0.5 |
| Sodium excretion (in meq/min) | 93±7.6 | 46±5.3 | < 0.001 |
| Potassium excretion (in meq/min) | 32±4.1 | 17±2.7 | < 0.001 |

As Table 1 shows, under the influence of insulin the tubular secretion of diodone increased on the average by 17.7%. Meanwhile, the diuresis fell by 28.5% on account of an increase in tubular reabsorption.

In six acute experiments in which insulin was injected into the left renal artery, the direct effect of the hormone on the tubular epithelium was studied. The level of secretion, the diuresis, and the glomerular and tubular reabsorption before injection of insulin were approximately equal in both kidneys. During infusion of insulin the maximal secretion of diodone in the left kidney was increased by 39.1%. This was accompanied by a unilateral decrease in diuresis, indicating that the insulin acted directly on the tubular epithelium (Table 2).

The decrease in sodium and potassium excretion by the perfused kidney may be the result of an increase in their reabsorption in the tubule under the influence of insulin.

In the experiments on rabbits, insulin was found to stimulate the accumulation of diodone by slices of renal cortex. In the series of experiments in which insulin was injected into the animals the coefficient of accumulation was 7.6±0.4, while in the control experiments it was 6.1±0.2 ($P < 0.01$). When insulin was added to the incubation medium, the coefficient of diodone accumulation by the slices was increased by 26.5% ($P < 0.001$). The results of these experiments showed that insulin depresses diuresis and excretion of electrolytes and increases the maximal tubular secretion and the accumulation of diodone by slices of renal cortex.

According to some investigators [1, 2, 3, 8, 9] insulin stimulates intracellular metabolism, promotes the formation of high-energy phosphorous compounds, increases the activity of ATPase and acid and alkaline phosphatases, and brings about the genetic induction of several enzymes. Perhaps as the result of these changes the functional activity of the tubular epithelium is stimulated, with an increase in the reabsorption of $Na^+$ and $K^+$ and an increase in the maximal secretion of diodone.

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