10459 P

Effect of Adrenalectomy upon Intestinal Absorption of Sodium Chloride.

WILLIAM G. CLARK. (Introduced by Maurice B. Visscher.)

From the Department of Zoology, University of Minnesota, Minneapolis, and the Scripps Metabolic Clinic, La Jolla, Calif.

It is well established that adrenal insufficiency provokes a negative salt and water balance in most mammalian organisms which have been studied, and that this condition can be corrected for the most part by cortical hormone and/or salt therapy. Several workers have reported that this negative balance is due to a primary renal effect; some have indicated it to be due also to primary extra-renal disturbances; and still others have stated that the electrolyte disturbances are secondary to disturbances in carbohydrate metabolism.

In another study[1] it was found that healthy adrenalectomized rats, maintained on Rubin-Krick salt drinking-fluid and stock diet for periods up to 2 weeks, absorbed glucose at the same rate as controls. A modified Cori technic was used, employing the intact rat. This finding confirmed Deuel, *et al.*,[2] who also used this technic; and failed to confirm the conclusions of Wilbrandt and Lengyel,[3] and Verzar, *et al.*,[4] who used the isolated intestinal loops of rats, cats, and dogs.

The present study indicates that healthy adrenalectomized rats absorbed NaCl more slowly than controls. The Cori technic was used in preliminary studies, and both sodium[5, 6] and chloride[7, 8] of the minced, leached gastrointestinal tract was determined in most cases, although this was not essential since stomach-emptying of control and adrenalectomized rats was comparable for both sodium and chloride. The stomach-emptying of the adrenalectomized rats varied far more than that of the controls, however, so that for small differences in intestinal absorption, the stomachs should be separately analyzed.

The intestinal absorption rates of both Na and Cl were comparable

---

1 Clark, W. G., and MacKay, E. M., in preparation.

2 Deuel, H. J., Jr., Hallman, L. F., Murray, S., and Samuels, L. T., *J. Biol. Chem.*, 1937, **119**, 607.

3 Wilbrandt, W., u. Lengyel, L., *Biochem. Z.*, 1933, **267**, 204.

4 Issekutz, B. V., Jr., Laszt, L., u. Verzar, F., *Arch. ges. Physiol.*, 1938, **240**, 612. (*Cf.* for earlier papers.)

5 Butler, A. M., and Tuthill, E., *J. Biol. Chem.*, 1931, **93**, 171.

6 Hoffman, W. S., and Osgood, B., *J. Biol. Chem.*, 1938, **124**, 347.

7 Van Slyke, D. D., and Sendroy, J., Jr., *J. Biol. Chem.*, 1923, **58**, 523.

8 Sendroy, J., Jr., *J. Biol. Chem.*, 1937, **120**, 405.

and those of the adrenalectomized animals were considerably less than the controls, although more variable.

No differences were found between adrenalectomized and control animals with respect to: concentrations of Na and Cl of the tissues of stomachs and intestinal tracts, concentrations of Na and Cl of the serum, hemoglobin concentrations of the blood, body weight changes, body (rectal) temperatures, and general activity. That the rats lacked cortical hormone was proved by the fact that they died of adrenal insufficiency within a few days after removal of the salt drinking fluid, and that they exhibited a marked diuresis. No effect of cortical hormone injections was found on intestinal absorption of NaCl by normal sham-operated controls. These details will be published elsewhere.

Later, a method of determining intestinal absorption similar to that developed by Barnes, *et al.*,[9] was used, separately rinsing residual, unabsorbed NaCl from the stomach and intestine of the subsequently etherized rat with isotonic, warmed sucrose after a definite absorption period following administration of NaCl to the intact animal (1 cc 3% NaCl per sq dec body surface). The results are summarized in Fig. 1 and are expressed as residual Cl found in the intestine as percent of the amount of Cl available for absorption by the intestine, after correcting for Cl found in the stomach. Thus the amount available would be the difference between the amount fed and the amount found in the stomach. The rinse method, however, requires no correction for chlorides which are leached from the tissues of the gastrointestinal tract when the Cori method is used.

In the author's opinion, this method is superior to the isolated loop method, since trauma associated with an abdominal incision and intestinal manipulation causes severe circulatory disturbances and shock in the adrenalectomized animal[10, 11] and would thus vitiate results obtained on the experimental animals. Experiments have shown that the NaCl obtained by rinsing the alimentary tract with isotonic sucrose 2-3 minutes after administration, represents approximately 96% of the amount fed. The 4% loss is understandable when it is considered that 1 drop of the 3% solution contained approximately 3 mg NaCl, and a drop or two in the oesophagus and mouth would decrease the recovery several percent. Furthermore,

[9] Barnes, R. H., Wick, A. N., Miller, E. S., and MacKay, E. N., PROC. SOC. EXP. BIOL. AND MED., 1939, **40**, —

[10] Freed, S. C., PROC. SOC. EXP. BIOL. AND MED., 1933, **30**, 677.

[11] Swingle, W. W., Parkins, W. M., Taylor, A. R., and Hays, H. W., *Am. J. Physiol.*, 1938, **124**, 22. (*Cf.* for earlier papers.)

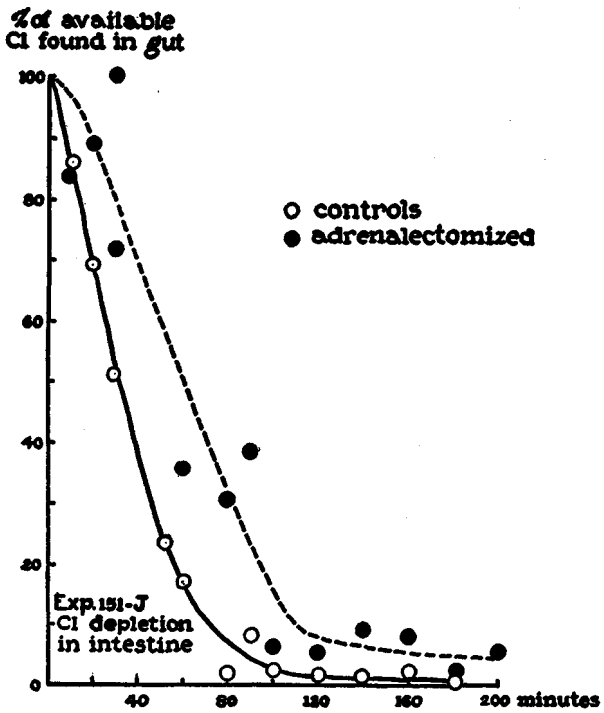

FIG. 1.

Hamilton[12] showed that radioactive salts may appear in the extremities 3-5 minutes after oral administration of isotonic solutions to the human.

Fig. 1 shows the decreased rate of intestinal absorption of Cl in the healthy, active adrenalectomized rat. As pointed out above, other experiments have shown that Na behaves just as Cl. Practically 100% absorption has occurred in approximately 90 minutes.

The results of this work, experimental details of which will appear elsewhere, and those of the previous work on glucose absorption, support the theory that the electrolyte metabolism of the adrenalectomized animal is affected by a primary disturbance of membrane behavior rather than by a secondary disturbance in the phosphorylation of glucose. The results also indicate that this primary disturbance may occur in membranes other than in the kidney. Further aspects of this membrane disturbance are being investigated at the present time.

[12] Hamilton, J. G., *Am. J. Physiol.*, 1938, **124**, 667.