

Growth in Adrenalectomized Puppies on Diet Low in Potassium, High in Sodium Chloride, Sodium Citrate.

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That the adrenal cortex or the cortical hormone is not necessary for maintenance of adrenalectomized adult dogs, adequately supplied with sodium chloride and sodium bicarbonate (or better, sodium citrate) was reported in June, 1935, by Harrop *et al.*,¹ and by one of us.² While Harrop and his coworkers paid little attention to the concentration of potassium in the diet, Allers^{2,3} fed synthetic diets low in potassium and was able to sustain more normal balances in electrolytes provided sufficient sodium salts were added to the diet. That feeding small amounts of a potassium salt suddenly produces typical symptoms of insufficiency in such treated animals has very recently been shown by Allers, Nilson and Kendall.⁴ The latter investigators have further shown that the ability to reproduce is also normal in both the adrenalectomized male and female dogs maintained in good condition by sodium salts and a low potassium diet.

We now report that growth also occurs in adrenalectomized puppies in the absence of cortin. Grollman and Firor⁵ have stated that growth ceases after adrenalectomy in rats, cats and dogs that are maintained in a state of "chronic insufficiency" by giving only small amounts of cortical hormone. This observation is not invalidated by our results, since our animals have not presented indications of insufficiency, except occasionally when sodium salts were withheld for short periods. Our data show that following the removal of the second adrenal and without the administration of any cortical hormone after the first or second day, 2 puppies, when fed a diet high in sodium chloride and sodium citrate but low in potassium steadily gained in body weight. The diet consisted of 54.5% cracker meal, 17% crude casein, 20% lard, 6% bone ash, and

¹ Harrop, G. A., Soffer, L. J., Nicholson, W. M., and Strauss, M., *J. Exp. Med.*, 1935, **61**, 839.

² Allers, W. D., *Proc. Staff Mayo Clin.*, 1935, **10**, 406.

³ Allers, W. D. (in press).

⁴ Allers, W. D., Nilson, H. W., and Kendall, E., *Proc. Staff Mayo Clin.*, 1936, **11**, 283.

⁵ Grollman, Arthur, and Firor, W. M., *Am. J. Physiol.*, 1935, **112**, 310.

2.5% pasteurized brewer's yeast. Each day the puppies were fed 90 calories per kilo body weight of the ration, to which were added 10.7 mg. MgO, 1.5 mg. NaI, and 15 mg. ferric citrate, per kilo body weight, and 15 cc. of cod liver oil. Fresh liver was occasionally added to the diet, but was withheld when it provoked symptoms of weakness. The first animal has reached almost mature size (3 months after the second operation) and has remained in excellent condition except when the sodium salts were experimentally reduced, at which times weakness and anorexia promptly ensued. Its body weight increased from 20 to 30 lbs. The second puppy, operated at an earlier age (about 3 months) has also grown rapidly, gaining 65% of its original body weight within 48 days, and was sensitive to a decreased intake of sodium salts. X-ray records demonstrate growth in the skeletal bones, and teeth.

To maintain adrenalectomized adult dogs without cortin requires the exercise of meticulous care, as emphasized elsewhere,⁸ but the task is even greater when puppies are used, since their stomachs are extremely sensitive to the high concentration of salts in the diets. To avoid nausea the salts were incorporated in a medium that remained quite impervious to gastric juice but slowly dissolved in the intestine. One mixture found to be satisfactory was powdered sodium chloride, powdered sodium citrate, and powdered commercial gastric mucin, which, after intimate mixing, were carefully mixed with stearic acid heated several degrees above its melting point. After solidification the mass was broken into particles approximating the size of a kidney bean. Weighed portions of this salt mixture were added to the daily diet low in potassium. Whether this mixture prevents nausea depends upon the ratio of the constituents. Usually the following proportion was satisfactory: 1 part mucin, $\frac{1}{2}$ part NaCl, $\frac{1}{2}$ part Na-citrate, and 1 part stearic acid. The puppies required 20 to 30 gm. of such a mixture, in addition to 0.5 to 2 liters of 0.7% saline daily.