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Effect of Food and Water on Thyroid Uptake of Radioiodine (I^{131}) in Rats. (20480)

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Based on the avidity of the thyroid gland for iodine, diagnostic tests using tracers of radioactive iodine have been devised for studying patients with thyroid disease. Many variations of these tests have been described in the last few years, ranging from measurements of early accumulation rate over the thyroid gland to 24-hour uptake studies(1-4). The accumulation rate of iodine in the thyroid gland is in part dependent upon the plasma level of iodine. Therefore, alterations in plasma concentration may produce changes in the accumulation rate of iodine in the thyroid. Since plasma levels might be affected by variation in gastrointestinal or renal activity, and since no standard procedures having to do with restricted amounts of food or fluid are instituted during routine thyroid studies, it seems advisable to study the effects of these substances on the total thyroid accumulation of a tracer dose of radioactive iodine.

Method. Male albino rats, C. F. Wistar strain, were used. The animals weighed from 120 to 150 g at the onset of the experiment. For a period of 4 weeks prior to the study, the animals were placed on distilled water and an iodine-poor diet. The diet was similar to that used by Levine and Remington(5) in their studies on goiter production in rats.† It was found necessary to use an iodine-poor diet for this experiment since stock diet contains sufficient stable iodine to completely saturate the rat thyroid. The animals were separated into 8 groups of 3 animals, and were given single intraperitoneal injections of 0.1 μc of radioactive iodine per g of body weight. All animals were placed in metabolism cages and their excreta collected throughout the entire period of the experiment. Groups 1-A and 1-B received no water or diet food for 36 hours prior to the administration of the I^{131} and none during the period of the experiment. Groups 2-A and 2-B received diet food and water up to the time of injection but received none after the injection of I^{131}. Groups 3-A and 3-B received diet food and water up to the time of injection, but only distilled water after the injection. Groups 4-A and 4-B received diet food and water *ad lib.* prior to and following the injection of I^{131}. Animals in A groups were sacrificed at the end of 6 hours, and those in B groups at the end of 24 hours. The tissues to be studied were removed and dissolved in 30% potassium hydroxide. The excreta and carcasses were similarly treated. The radioactivity of aliquots of the various tissues were compared with standards. Measurements of gamma ray activity were made

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† This diet is the Rachitogenic Diet II (with added irradiated yeast) supplied by the Nutritional Biochemical Co. It contains ground gluten 20%, ground whole yellow maize 76%, calcium carbonate 3%, and sodium chloride 1%.

TABLE I. The Effect of Food and Water on the Distribution of Radioactive Iodine.

	6 hr				24 hr			
Group No.	1A	2A	3A	4A	1B	2B	3B	4B
Thyroid	56.1	51.3	30.2	18.1	40.4	36.1	15.8	7.0
Excreted	5.6	10.2	22.8	36.0	42.9	45.5	60.0	68.9
Stomach & contents	1.1	0.6	4.1	7.8	0.5	0.5	1.3	1.6
Remaining viscera	8.8	7.8	12.9	21.2	2.6	2.4	3.5	5.7
Carcass	16.0	17.1	15.8	14.6	10.5	12.1	9.6	10.2
Total recovery	87.6	87.0	85.8	97.7	96.9	96.6	90.2	93.4

Group No. 1, A & B. No food and water for 36 hr prior to and after inj.
2, No food and water after inj.
3, Distilled water only, after inj.
4, Diet food and water, *ad lib.*

with a scintillation counter and the results recorded in per cent of administered dose per total organ.

Results and discussion. As was previously shown by Levine and Remington(5), the low-iodine diet utilized in this experiment produced some enlargement of the thyroid gland in the test animals. The average thyroid weight of these animals was 170 mg/kg body weight as compared to control animals on stock diet whose thyroid weights were found to be an average of 120 mg/kg body weight. Histologically, there was evidence of moderate epithelial hyperplasia of the glandular elements with slight vacuolation of the colloid within the follicles.

Table I gives the 6- and 24-hour distributions of radioactive iodine in the 8 groups of animals, the results being averaged for each group. Fig. 1 graphically illustrates the effect of water alone, and food and water, on the thyroid uptake and excretion of radioactive iodine at 6 and 24 hours. It is obvious from the data that water alone, and food and water, have a profound effect upon the accumulation of I^{131} in the thyroid gland. In Fig. 1 it can be seen that at the end of 6 hours the uptake of I^{131} in the thyroid gland is 56 and 51% respectively in those groups (1-A and 2-A) where no food or water were given following the administration of the tracer dose. On the other hand, 30% of the tracer dose was observed to be in the thyroid tissue in those animals receiving only fluid (3-A); and 18% in animals given both food and water (4-A). Similar findings were observed at the end of 24 hours with a more profound effect due to food and water.

To obviate the conclusion that food and water given to the animals in Groups 3 and 4 contained sufficient stable iodine to influence and compete with the tracer dose of I^{131}, samples of diet food and distilled water were analyzed for iodine content by the method of Barker *et al.*(6). The diet food was found to contain an average of $14.6 \pm 1.7\ \gamma$ per kilo of food; and distilled water was found to contain 1.5 γ per liter. Estimating that a 250 g rat will consume approximately 20 to 30 g of food, and from 20 to 30 cc of water in a 24-hour period, the amount of exogenous iodine from the food and water would amount to approximately 0.3 γ. In order to be certain that this amount of stable iodine was not influencing the thyroid uptake of the tracer amount of radioactive iodine, 6 animals were divided into 2 groups, half receiving carrier-free I^{131} and the other half receiving 1.5 γ of stable iodine plus the tracer dose. After 24 hours the animals were sacrificed and analysis of the thyroid tissue and excreta for radio-

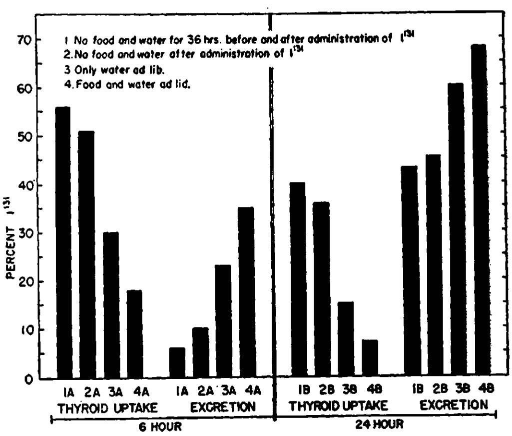

FIG. 1. Shows the influence of food and water alone on the thyroid retention and excretion of 1^{131}.

activity showed no significant difference.

The ability of water alone to produce a marked reduction in thyroid accumulation of I^{131} is intriguing. Although the exact mechanism is obscure, it must be assumed that renal excretion plays a great part. It is well known that following the administration of a tracer dose of radioactive iodine, the kidneys rapidly eliminate all iodine that is not retained in the thyroid. The results of this experiment indicate that one can markedly increase the total excretion of a tracer dose of radioactive iodine by simply allowing the animals to ingest fluid.

The mechanism by which food and water affect the distribution of I^{131} is again not well understood. Whereas fluid alone will produce a reduction in the final thyroid uptake (Groups 3-A and B), the addition of food further reduces the thyroid accumulation, and conversely increases the excretion of the tracer dose. It has been shown that this secretory activity of the stomach will alter or reduce the early accumulation rate of I^{131} in the thyroid gland(7). However, because of the rapid reabsorption of iodide ion by the gastrointestinal tract, it has been previously assumed that the ultimate retention of the tracer dose in the thyroid gland will not be affected. The fact that the per cent excreted in Group 4 is much greater than in Groups 1, 2, and 3 shows that gastric activity alone in some way reduces the final uptake of I^{131} in the rat thyroid gland.

It should be mentioned that the results obtained in this experiment may pertain only to the iodine-deficient rat and need not apply to a normal rat or one on a maintenance dose of iodine. However, from a preliminary study in rats fed a weight maintenance diet of stock food (Frisky pellets), it was found that food and water influenced the retention of I^{131} in the thyroid gland. In the control group (those receiving no food or water after the tracer dose was given), a 12% retention of I^{131} in the thyroid was obtained. In a second group (those given food and fluid after injection of the tracer dose), the retention of I^{131} was found to be only 6%.

Because of the results obtained in rats, it appears reasonable to assume that certain control measures should be instituted when thyroid activity is to be evaluated clinically. In studying early accumulation rates of I^{131} over the thyroid gland in patients, we have found it necessary to withhold food and fluid for several hours prior to the test and during the early measurement period. We have found that food in the stomach will definitely retard the early accumulation rate of I^{131} over the thyroid gland. These findings are considerably more evident in patients with over-active goiters, in whom the bulk of the tracer dose is rapidly accumulated in the thyroid gland. It has been much less evident, however, in euthyroid patients where not only the accumulation rate but also the total retention of I^{131} are considerably lower. Whether the final thyroid retention of the tracer dose is similarly affected as well, is still to be determined.

Summary. 1. Data have been presented which show that intake of food and water, and water alone, influence the uptake of radioactive iodine in the thyroid gland of rats on an iodine deficient diet of Remington and Levine. At 6 and 24 hours, the thyroid uptake is reduced significantly if water is given. An even more profound reduction in uptake and correspondingly increased excretion has been observed if both food and water are allowed. 2. It has been suggested that gastric activity and fluid intake should be controlled when radioactive iodine uptake is to be used for evaluating and treating thyroid disease.

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