

# EFFECT OF THE THYROID HORMONE ON THE EVACUATORY FUNCTION OF THE STOMACH\*

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Insufficient work has been done on the effect of the thyroid hormone on the evacuatory function of the stomach [3, 4, 5, 6]. The study of this problem has been complicated by the great variability in the evacuatory function of the stomach, by the deficiencies of the generally applied method for its quantitative evaluation, by its relative insensibility, and by the insufficient time available for observations (the bulk of water introduced is evacuated into the intestine within 30-45 minutes).

We have frequently noted the variability of the evacuatory function of the stomach. On one occasion we found that no more than 5-10 ml of 300 ml of water introduced into a dog's stomach passes into the duodenum during the first 15 minutes, while during the following 15 minutes 100-200 ml are evacuated, and on another occasion we found the opposite effect. Such fluctuations are, however, observed only when the observations are made for short periods of time. They are less pronounced when the period of observation is 1 hour, and still less so when it is 3-4 hours [2]. For this reason, evaluation of the state of the evacuatory function of the stomach should not be based on observations of short duration.

We have examined the effect on the evacuatory function of the stomach of excess or deficiency of thyroid hormone (in the same animals), using the method of S. G. Genes [2].

## EXPERIMENTAL METHODS

The experiments were performed on 4 dogs with Basov gastric fistulae: Julia, Tyulpan, Mishuk, and Bars. Volumes of 500, 700, and 800 ml of water were introduced into the stomach at 15 minute intervals. A quarter or a third of the water passed into the duodenum over a 15 minute period; only rarely was the amount somewhat greater or smaller than this.

The dogs were taken out to urinate at hourly intervals, in order that filling of the bladder should not affect the evacuatory function of the stomach. The weight of the animals was still slightly above the initial value at the end of the 4-hour experimental periods, but was back to the initial figure after 2-3 hours, and only rarely after 4 hours.

## EXPERIMENTAL RESULTS

Our control experiments showed that the volume of water passing from the stomach into the duodenum was about the same during each hour (Tables 1-4). The volume evacuated differed for different dogs, this being to some extent due to differences in the amounts introduced into the stomach. The water loading did not affect the composition of the blood; hourly analyses showed that the hemoglobin content remained constant.

The condition of the evacuatory function of the stomach was studied at the beginning and the end of a period of feeding with raw thyroid gland.

The amount of water leaving the stomach rose somewhat (by 7, 11, 13, and 19%) at the beginning of the period of thyroid feeding.

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TABLE 1

Passage of Water from the Stomach to the Duodenum of the Dog Tyulpan (weight 25 kg)

Experimental series	No. of experiments	ml of water transferred during					Total water transferred during 4 hrs, as %
		1st hour	2nd hour	3rd hour	4th hour	4 hours	
Control, January 27 to March 6.	7	1089	1201	1140	1160	4590	100
Daily feeding with 50 g portions of raw thyroid gland (March 10-31)	4	1289	1261	1276	1270	5086	111

TABLE 2

Passage of Water from the Stomach to the Duodenum of the Dog Mishuk (weight 24 kg)

Experimental series	No. of experiments	ml of water transferred during					Total water transferred during 4 hrs, as %
		1st hour	2nd hour	3rd hour	4th hour	4 hours	
Daily feeding with 50 g portions of raw thyroid gland (March 9-April 7):							
March 10-20	4	1245	1325	1319	1178	5067	119
April 3-7	2	1170	1380	1195	1253	4998	117
After discontinuing feeding with raw thyroid gland April 10-24	3	893	1177	1227	1358	4655	109
Daily administration of 3-6 g of methylthiouracil (April 27-July 24):							
May 6-15	3	997	1198	1213	1208	4616	108
May 19-June 9	7	615	992	1021	1024	3582	84
June 18-July 24	8	627	761	872	907	3167	74
After discontinuing 6-methylthiouracil administration (July 24-Sept 30)							
July 28-September 30	9	727	897	1030	1025	3679	86

By the end of this period, the evacuatory function of the dog Bars had risen by a further 11%, remained unchanged for Mishuk, and fallen somewhat for Julia, becoming only 7% above normal (there were no data for Tyulpan over this period).

Over a period of about 3 weeks after discontinuing thyroid feeding, the evacuatory function of the stomach of the dogs Julia and Bars had returned to the normal values, while that of Mishuk was still somewhat elevated.

Prolonged oral administration of 6-methylthiouracil caused a 3-5 fold increase in weight of the thyroid glands, and led to the development of various trophic changes (eczema, falling out of the hair, skin ulcerations). The evacuatory function of the stomach was depressed, but only to a small degree, and differently for each dog: in Bars by 3 and 9%, in Julia by 6 and 19%, in Mishuk by 16 and 26% (after an initial rise of 8%).

Augmentation of the evacuatory function took place only very slowly after discontinuation of the 6-methylthiouracil.

TABLE 3

Passage of Water from the Stomach to the Duodenum of the Dog Julia (weight 18 kg)

Experimental series	No. of experiments	ml of water transferred during					Total water transferred during 4 hrs, as %
		1st hour	2nd hour	3rd hour	4th hour	4 hours	
Control Jan 30- March 7	7	594	794	712	600	2700	100
Daily feeding with 50 g portions of raw thyroid gland (March 9- April 7)							
March 11- 21	4	774	854	716	718	3062	113
April 4- 8	2	880	800	698	610	2888	107
After discontinuing feeding with raw thyroid gland							
April 11- 28	4	510	749	738	631	2628	97
Daily administration of 2.25- 3.25 g of 6-me-thylthiouracil (April 28- July 9):							
May 4- June 16	13	466	648	619	731	2536	94
June 27- July 4	2	455	400	685	645	2185	81
After thyroidectomy July 9							
July 14- August 1	6	519	639	614	661	2433	90
August 8- October 27	7	400	519	545	589	2054	76
Daily feeding with 10- 20 g portions of raw thyroid gland (October 27 to November 17)							
December 3- 17	4	650	736	696	491	2573	95

We performed a thyroidectomy on Julia and Bars, in order to elucidate the effect of the goiter and the hypothyroidism produced by 6-methylthiouracil administration. This caused a slight lowering of evacuatory function at first (by 1 and 10%), with a somewhat greater one (by 24 and 33%) after 20-30 days. It may be concluded that prolonged administration of high doses of 6-methylthiouracil depresses thyroid function, and the weakening of the evacuatory function of the stomach observed in this condition is ascribable to the hypothyroidism produced. Subsequent feeding of the thyroidectomized dogs with raw thyroid glands (10-20 g daily) gave a rapid normalization of evacuatory function.

Excess or deficiency of thyroid hormone has an effect on all the functions of the organism, mediated basically through various parts of the central nervous system (for references see S. G. Genes[1]).

In order to elucidate to what extent the effect of thyroid hormone on the evacuatory function of the stomach is mediated through the central nervous system, we put the dogs to sleep with the aid of Medinal. The results of these experiments are presented in Table 5.

The experiments showed that, in profound narcosis produced by Medinal, the evacuatory function of normal dogs is weakened, by 24, 39, and 42%, on the average, in 3 dogs, and raised by 6% in the fourth; the corresponding figures for three thyroid-fed dogs were 7, 11, and 42%, for 6-methylthiouracil-treated dogs 20, 25, and 36%, and for two thyroidectomized dogs 30 and 38%, below waking values.

These data permit the conclusion that excess thyroid hormone affects central nervous system regulation of the evacuatory function of the stomach to a much smaller degree than it does metabolic processes, with the connected functions of the cardiovascular and respiratory systems. Absence of thyroid hormone leads to considerable weakening of central nervous regulation of the evacuatory function of the stomach.

TABLE 4

Passage of Water from the Stomach to the Duodenum of the Dog Bars (weight 27 kg)

Experimental series	No. of experiments	ml of water transferred during					Total water transferred during 4 hrs, as %
		1st hour	2nd hour	3rd hour	4th hour	4 hours	
Control Jan 30- March 7	7	1299	1229	1315	1062	4955	100
Daily feeding with 50 g portions of raw thyroid gland (March 9- April 7)							
March 11- 21	4	1525	1548	1214	1024	5311	107
April 4 and 8	2	1713	1643	1333	1133	5822	118
After discontinuing feeding with raw thyroid gland							
April 9- 28	4	1171	1278	1364	999	4811	98
Daily administration of 3.25-6.5 g of 6-methylthiouracil (April 28- July 14):							
May 4- June 24	15	1166	1194	1280	1146	4786	97
July 4 and 14	2	985	1140	1070	1315	4510	91
After thyroidectomy (July 20):							
July 29- August 4	3	1097	1200	1325	1247	4869	99
August 10	1	450	840	915	1095	3330	68
August 18- October 27	6	632	798	956	898	3284	67
Daily feeding with 10- 20 g portions of raw thyroid gland (October 27 to November 17)							
November 3- 17	4	1383	1341	1350	843	4916	100

TABLE 5

Effect of Medinal-induced Sleep on the Evacuatory Function of the Stomach

Experimental series	State of animals	No. of experiments	Tyuplan		Mishuk		Julia		Bars	
			transfer of H <sub>2</sub> O from the stomach after 4 hours							
			ml	%	ml	%	ml	%	ml	%
Control	Waking	5	4525	100	4319	100	2729	100	4967	100
	Sleeping	2	4805	106	2498	58	2088	76	3020	61
Thyroid feeding	Waking	4	5086	100	5066	100	3061	100	5311	100
	Sleeping	2	4727	93	2933	58	1768	58	4738	89
Administration of 6-methylthiouracil	Waking	10			3892	100				
		13					1811*	100	4786	100
		15								
	Sleeping	2			2490	64	1353	75	4830	80
After thyroidec-tomy	Waking	6					2433	100		
		5							4687	100
	Sleeping	2					1513	62	3301	70

\* Data from 3-hour experiments

Medinal narcosis leads to a much more rapid and pronounced development of depression of the evacuatory function of the stomach than does thyroidectomy. Much less water is passed from the stomach to the duodenum of narcotized dogs which had been subjected to prolonged thyroid feeding than in the waking state. Medinal administration does not, however, fully abolish the action of thyroid hormone. Thus, evacuation in the thyroid-fed dogs Mishuk and Bars during narcotic sleep was considerably greater (by 17 and 50%) than in the control series. It follows that, for the majority of the dogs, the central nervous system, having been modified by prolonged administration of thyroid hormone, gives a weaker response to Medinal than in normal animals. Higher doses of Medinal are required to induce sleep in hyperthyroid dogs than in the control experiments (0.24-0.27 g instead of 0.22 g per kg body weight). In spite of these elevated dosage levels, the stage of excitation was considerably prolonged in these animals, and their sleep was interrupted from time to time. They usually awoke after 3-4 hours. Induction of sleep was particularly difficult in the case of the dog Tyulpan, and his sleep was uneasy; a restless, drowsy condition supervened, lasting for days, and he finally died in this condition, in spite of administration of analeptics (camphor, caffeine, strychnine). Hypothyroid dogs reacted differently towards Medinal. Such dogs fell asleep after doses of Medinal not exceeding 0.2 g per kg body weight. The amount of water evacuated from the stomach during such sleep was much smaller than during the thyroid feeding period.

The inconsiderable strengthening of the evacuatory function of the stomach observed during prolonged thyroid feeding is evidence of the great stability of this function, particularly if we consider the marked rise in pulse rate (nearly 3-fold) and respiratory rate (nearly 7-fold), and the fall in weight (by 9-11%). This stability may be a result of the low sensitivity to thyroid hormone of the parts of the central nervous system concerned in the regulation of the evacuatory function of the stomach, and of the peculiarities of the vegetative ganglia of the gastrointestinal tract. The pronounced depression of the evacuatory function of the stomach found after administration of Medinal is evidence of the role of central nervous system regulation. Yet the fact that the evacuatory function retains 58, 61% or even more of its waking value during profound sleep necessitates an evaluation of the role of the vegetative system ganglia in the evacuatory function of the stomach. I. P. Pavlov wrote the following, in 1898: "The stomach plays an important part in the movement of food. It knows when it is filled, and, unless there is a pyloric obstacle, it expresses its contents."

Depression of evacuatory function in hypothyroidism and after thyroidectomy is evidence that the continuous action of thyroid hormone on the relevant parts of the central nervous system is essential for the normal functioning of the evacuatory mechanism of the stomach.

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\* In Russian.