Some Normal Variations in the Emptying-Time of the Human Stomach
(Using a Carbohydrate Meal)*

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IN the course of some experimental work upon the emptying-time of the human stomach (1) considerable data pertaining to the normal emptying-time was obtained. Some rather interesting variations were noted in connection with these data, and led us to believe that this report might prove of interest to gastroenterologists and to experimental physiologists.

It is well understood that many factors may influence the rate of gastric emptying, and that even when every attempt is made to control all of these factors and to produce uniform experimental conditions, a careful evaluation of results is necessary.

METHOD

Nine normal young adult male medical students were selected for this work. They were given a standard meal, which was prepared as follows: 15 grams of farina and 1 gram of salt were added to 350 c.c. of boiling water and the mixture was cooked until the total volume was 200 c.c. This semi-solid preparation was kept in an electric refrigerator overnight. The next morning 50 grams of barium sulphate were added, and the meal was eaten at 8:30 A. M.

After the subjects had eaten the meal they were asked to lounge about the laboratory, and for the main part to keep seated in comfortable positions. They were allowed to spend part of the time in reading light fiction, such as may be found in current non-scientific periodicals. In short, they were asked to relax, physically and mentally, as much as possible, without making a studied effort to do so. Every precaution was taken to shield them from extraneous influences.

TABLE I

Table I gives the details of the results obtained

Subject Number	Emptying Time in Hours					Number of Tests
	Shortest	Longest	Arith. Mean (Average)	Mode	Median	
1.	0.75	1.50	1.03	1.00	1.00	7.
2.	1.25	2.00	1.58	1.50	1.50	9.
3.	1.75	2.25	1.96	2.00	2.00	7.
4.	1.50	2.50	2.00	1.75	2.00	11.
5.	1.75	2.50	2.17	2.25	2.25	10.
6.	2.25	2.25	2.25	2.25	2.25	7.
7.	2.25	2.75	2.40	2.25	2.25	7.
8.	2.25	2.75	2.50	2.50	2.50	10.
9.	2.25	3.50	2.81	2.75	2.75	9.
Average			2.077			8.5

The emptying-time of the stomach was determined fluoroscopically. After a few determinations had been made upon any individual it was relatively easy to estimate at about what time gastric evacuation would occur, for, as is pointed out later, the emptying-time of the stomach for each individual remained singularly constant from day to day. This method of estimation prevented undue exposure to the Roentgen ray.

RESULTS

Nine subjects were used, and a total of 77 tests was run. The arithmetic mean (average) of the emptying time of the stomach of the 9 individuals was 2.07 hours. The arithmetic mean of the 77 tests was 2.08 hours. The extremes of the emptying time for the subjects were 1.03 and 2.81 hours, respectively. The extremes for the tests were 0.75 and 3.50 hours, respectively.

DISCUSSION

It is interesting to observe that the emptying time of any individual varied but little from day to day. Even in such cases as subjects number 4 and 9 respectively, where there is considerable difference between the extremes, the mode and the median check closely with the average emptying time. A similar constancy has been observed in previous work upon animal subjects (2).

It must be noted that our standard meal consisted almost entirely of carbohydrate. It is doubtless true that a meal with a higher protein content would be retained longer by the stomach, since such a meal would be subjected to a certain amount of gastric digestion before it would be allowed to leave the stomach. The meal we used was chosen for ease in preparation and administration, and to conform with standards previously set up by other workers on the emptying time of the stomach (3).

It is seen that the emptying-time of the stomach of subject number 1 is considerably shorter than the average. This subject reported that when in perfectly normal health he had 2 or 3 bowel movements every day. Subjects number 8 and 9, each with a rather long emptying time, were high-strung individuals.

These points of information are not given in an attempt to explain why the emptying time in these cases varied considerably from the average, for it is certain that in a series of persons chosen at random a number of just such individuals would be encountered. We feel, therefore, that the subjects used in this work represent a fairly accurate cross section of their group.

Owing to the small number of subjects used in this work no attempt was made to correlate our objective

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findings with weight, physique, mental makeup, or any other characteristic.

SUMMARY

The normal emptying time of the stomach of 9 young adult males was determined fluoroscopically, under carefully controlled conditions. The standard meal used consisted chiefly of carbohydrate; the preparation of the meal is described in the body of this paper.

A total of 77 tests was made. The arithmetic mean (average) of the emptying time of the 9 subjects was 2.07 hours. The arithmetic mean for the 77 tests was 2.08 hours. The extremes for the subjects were 1.03 and 2.81 hours respectively. The extremes for the tests were 0.75 and 3.50 hours respectively.

It was found that the emptying time of the stomach of any individual remained strikingly uniform from day to day, but that great individual variations exist.

REFERENCES

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2. Van Liere, E. J., Lough, D. H., and Sleeth, C. K.: "Normal Emptying Time of the Stomach of the Dog." *Proc. Soc. Exp. Biol. and Med.*, Vol. 31, pp. 85-87, 1933.
3. Hellebrandt, F. A.: *Personal Communication.*

ABSTRACTS

RIEGEL, CECILIA, RAVDIN, I. D., MORRISON, PHILIP J., AND POTTER, MILTON J.

Studies of Gall Bladder Function. XI: The Composition of the Gall Bladder in Pregnancy. J. A. M. A., 105:1343, Oct. 26, 1935.

Gall bladder disease follows pregnancy too often to be considered a mere coincidence. It has been thought that this results from some alteration in the bile during pregnancy. It has been shown that alterations in the chemical composition of the bile accompanies biliary tract disease and previous studies have demonstrated that damage to the gall bladder wall is accompanied by marked changes in the composition of gall bladder bile. It therefore becomes very interesting to know what the gall bladder bile removed from pregnant patients at term with no history of gall bladder disease would reveal. Data from the studies of thirty-four specimens of such bile removed from living women at term during the course of cesarean section revealed that the composition of such bile was changed from the normal. Chemical examination of this bile revealed that the cholesterol concentration is increased while the bile salt concentration is below normal. These changes in the pregnant gall bladder bile are in the direction that one would expect to precede stone formation.

Francis D. Murphy, Milwaukee.

DENNY-BROWN, D., AND ROBERTSON, A. GRAEME.

An Investigation of the Nervous Control of Defaecation. Brain, 58, 256-310, 1935.

The defaecatory process in healthy man and the automatic defaecation resulting from destructive lesions of the sacral cord were studied.

(1) Where the sacral innervation of the rectum and anus has been destroyed, there occurs contraction of the rectum with reciprocal relaxation of the anal sphincter. This reciprocity is nervous in mechanism, being related solely to the peripheral (intramural) nervous plexus. The adequate stimulus for relaxation of the anal sphincter is tension upon the wall of the rectum. Changes in tension are more efficient than passive tension.

(2) In "reflex defaecation" (where the sacral portion of the spinal cord is intact and is in nervous connection with the rectum and anus) the process is that of progressive and fused rectal contractions.

(3) The automatic and reflex responses are not mediated by the hypogastric nerve (*i.e.*, they are not under the control of the sympathetic nervous system).

(4) Voluntary control over defaecation extends only to the external voluntary sphincter ani. The external sphincter is not tonic, but it contracts synergistically with the abdominal parietes in the course of the *flexion* reflex.

(5) If delivery of faecal material to the colon is adequate, the mechanism of defaecation depends primarily upon the reaction of the rectum to distension.

M. H. F. Friedman, Montreal.

ARNDORFF, J. R., BERGH, G. S., AND IVY, A. C.

"Peptic" Ulcer and the "Anxiety Complex." S. G. and O., Vol. 61, No. 2, pp. 162-168, Aug., 1935.

The Authors performed experiments designed to determine whether chronic peptic ulcers could be produced in the dog by:

1. A sustained stimulation of the motor activity of the stomach.

2. Maintenance of the secretory activity of the stomach at a high level.

3. Continuous motor stimulation together with a high acid level. Since even the wildest of jungle animals soon become accustomed to the unnatural conditions of captivity, and, according to those who are familiar with their habits, show no signs of emotional stress, it was not possible to study the effect of that factor in the production of peptic ulcer.

Three groups of dogs were studied. The first group was given 2.5 milligrams per dose up to 37 days. The second group was given 2 milligram doses of histamine over periods varying from 63 to 66 days. The third group was given a mixture of pilocarpine and histamine in doses of 2 milligrams each for periods up to 58 days. Injections were given every two hours for 10 doses daily after which the dogs were given a "smooth" ground diet. Gastric analyses, throughout the 24 hour period, were made one to three times a week. At the completion of the experiments the animals were sacrificed, and careful autopsies were performed. Sections were made of the liver, kidneys, adrenals and stomach.

Most of the dogs in the first group showed no change throughout the intestinal tract except a slight injection of the duodenum in some cases. None of the dogs in the second group showed chronic ulcers in the intestinal tract at the completion of the experiment; some showed small superficial erosions. In all of the dogs in that group a high free acidity was found throughout the experiment. In one of twelve dogs in the third group a small erosion was found in the stomach. The intestinal tracts of the others were found to be normal. The liver, kidneys and adrenals were found to be normal in all dogs excepting those receiving obviously toxic doses of the drugs.

The Authors conclude that hypermotility of the stomach in combination with high acidity, as produced by pilocarpine and histamine, respectively, does not produce chronic peptic ulcers in the dog.

A large bibliography accompanies the article.

Nelson M. Percy, Chicago.