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Hunger Sensations in a Patient After Total Gastrectomy.

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The contraction of the empty stomach is regarded as an essential element in the sensation of hunger in man and animals on the basis of numerous experimental studies, although the possibility of other factors contributing to hunger has been considered. Carlson,[1] and Ivy and Vloedman[2] expressed interest in the question of hunger following removal of the stomach but were unable to find in the literature any reports based upon complete gastric excision.

An opportunity to investigate the question of hunger sensation in man following removal of the stomach was afforded by a patient upon whom total gastrectomy had been performed (by O.H.W.) for carcinoma of the stomach. In this operation the proximal end of the duodenum was closed and an anastomosis made between the esophagus and jejunum. As the removed specimen included the entire stomach, more than 2 cm. of esophagus and a portion of the duodenum, no doubt remains regarding the question of complete gastric excision.

Ten months following the procedure the patient returned for observation at our request, stating that he was in the best of health. X-ray examination demonstrated a good functioning stoma. There was no dilatation of the jejunum immediately distal to the anastomosis. Both vagi nerves were divided in the operative procedure but the patient's bowels moved regularly as previous to the operation. There was no evidence of anemia. He became hungry frequently and we felt that it would be of interest to investigate the hunger sensations in a gastrectomized patient.

Unfortunately he could not recall ever having had either before or after operation, any sensation he would describe as a hunger pang. To him the sensation was one of emptiness in the stomach followed by a feeling of general weakness. He was emphatic in stating that the sensation of hunger was now "just the same" as when he had a stomach. The only difference that he could notice was that he became hungry more frequently than before, which he

[1] Carlson, A. J., The Control of Hunger in Health and Disease. Univ. of Chicago Press. 1916.

[2] Ivy, A. C., and Vloedman, D. A., *Am. J. Physiol.*, 1925, **72**, 99.

attributed to the fact that he ate smaller quantities of food. Hunger was promptly relieved by eating a few crackers or drinking milk or buttermilk between meals.

In order to study the intestine for evidence of hunger contractions the patient was deprived of food and later instructed to swallow a small balloon which was fastened to the end of a rubber tube. The position of the balloon in the jejunum was verified by fluoroscopic examination. Tracings of the intestinal activity were recorded on a smoked drum through the medium of a water manometer. Each observation continued for about one hour.

Results. A tracing after 8 hours of starvation revealed practically no intestinal activity although the patient was very hungry.

He was starved for 24 hours but through an error was given a light breakfast 30 minutes before the tracing was obtained. Practically no intestinal activity was recorded. The patient stated that his hunger had been relieved.

Seven hours later when he had had only one light breakfast in a 32-hour period another tracing was taken. The patient was complaining of great hunger and weakness. The tracing revealed rather feeble rhythmical intestinal contractions of nearly uniform strength occurring 12 to 15 times a minute, but no hunger contractions comparable to those described for the stomach were observed. Respirations and body movements produced changes of pressure which were recorded on the drum, but these were satisfactorily differentiated from movements of the intestine itself. About 30 minutes after the introduction of the balloon the contractions became gradually weaker and finally ceased almost completely. This change followed the hypodermic injection of 5 units of insulin but probably was not due to the action of insulin. The patient stated at both the beginning and end of the experiment that he was experiencing hunger.

Although the hunger sensation described by this man is not characteristic of that said to be associated with gastric contractions it is a noteworthy fact that he was unable to detect any change in hunger sensations following complete gastric extirpation other than increased frequency of the hunger sensation. In this connection the observations of Ivy and Vloedman and of Quigley and Solomon[3] on the hunger contractions of the duodenum are of interest. The latter have reported that duodenal hunger contractions can occur in the absence of gastric motility. In the case reported here such a cause cannot be excluded; the activity of the small segment of

[3] Quigley, J. P., and Solomon, E. I., *Am. J. Physiol.*, 1930, **91**, 488.

jejunum investigated was not clearly related to the hunger which the man experienced. It is a significant fact, however, that patients with high intestinal fistula occasionally complain of constant hunger despite the frequent intake of food in liberal quantities.

The most important and definite observation brought out in the study of this patient is that a sensation interpreted by man as normal hunger which is relieved by the ingestion of food may occur following complete removal of the stomach.

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"True" Glucose Tolerance in Forty-two Normal Individuals.

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Glucose tolerance in 18 women and 24 men, all in excellent health except 2, who were subjects of acute coryza, and who were students or faculty members of the University of Minnesota or physicians in practice in the Twin Cities, was investigated.

The subjects were fasted approximately 12 hours, beginning at 7 o'clock on the evening before the test. Blood samples were drawn at the end of the fast period, and then 50 gm. of glucose and the juice of one half lemon in 125 cc. of water were administered orally. Additional samples were drawn at the half hour, hour, and 2-hour periods, following the glucose. Incidental glycosuria was not investigated.

Protein removal was effected by the Somogyi zinc precipitation method.[1] Sugar determinations were made in duplicate by the improved copper-iodometric titration of the Shaffer-Hartmann method. This was demonstrated at the Thirteenth International Physiological Congress in Boston, in 1929, and directions were distributed at that time.

TABLE I.

Glucose Tolerance Data in Normal Individuals.

	Mean (mg. %)	Standard Deviation	Coefficient of Variation
Fasting	83.12±0.56	5.38±0.40	6.5
Half Hour	123.77±1.69	16.25±1.20	13.1
One Hour	109.10±2.39	22.99±1.69	21.1
Two Hours	72.37±1.71	16.44±1.21	22.7

[1] Somogyi, M., PROC. SOC. EXP. BIOL. AND MED., 1929, **26**, 353.