54. The Humoro-Neural Regulation of the Gastric, Pancreatic and Biliary Secretions.

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It is known that insulin provokes gastric, pancreatic and biliary secretions and adrenalin inhibits them. The process of this action, however, is still quite obscure. We passed one tube into the stomach, another tube into the duodenum and after hypodermic injection of insulin or adrenalin collected the gastric and duodenal contents simultaneously which confirmed this data except that the influence of adrenalin on the gastric secretion was not so decisive. We found besides that ephedrine also has inhibitory influence on the secretion of digestive juices similar to those of adrenalin. The increased secretion of the gastric and pancreatic juices, after the injection of insulin, was manifested both in amount and in concentration. These evidences were especially marked when a pronounced hypoglycemia occurred and followed almost parallel to this, but were nearly negative when hypoglycemia failed. The decrease of the secretion of these juices, after the adrenalin or ephedrine administration, went parallel with the hypoglycemia, followed by an increased secretion when a reactive hypoglycemia occurred. As the gastric secretion is profuse after an injection of insulin, the stimulating influence of the pancreatic secretion might be induced partly at least by the secretin mechanism and it seems therefore necessary to decide whether, besides that there exists a primary stimulation. To solve this problem we worked on patients with achylia gastrica, but we met with difficulty when marked hypoglycemia occurred; most cases of achylia gastrica causing a profuse secretion of gastric juice rich in free hydrochloric acid. Finally we discovered cases of cancer of the stomach in which, after an injection of insulin, the gastric juice remained alkaline during the course of the collection and showed a marked increase in pancreatic and biliary secretions. Therefore it is definitely proved that insulin stimulates primarily the pancreatic and biliary secretions. Now it is most important to decide whether hypoglycemia and the increased secretion of the digestive juices are induced independently by insulin, or if hypoglycemia has any connection with this increased secretion. A marked hypoglycemia was produced in human subjects by insulin and
when the gastric, pancreatic and biliary secretions became profuse, an injection of glucose solution of different concentration (from 5 to 25 per cent) was made intravenously, intraduodenally or per return. A prompt and marked inhibition of the secretion of these juices occurred simultaneously with the increase of the blood sugar content regardless of the concentration and locality of the sugar introduced causing again profuse secretion when hypoglycemia recurred. Therefore it is definitely proved that hypoglycemia, if not alone, stimulates the secretion of these juices when insulin is administered. Now then it may be interesting to determine whether this stimulating influence acts peripherally to the tissue cells, or centrally to the centrum of the nervous system. An injection of atropine caused a prompt and distinct inhibition of the secretion of the juices induced by insulin, so that it is proved that the stimulating effect of hypoglycemia acts on the centrum of the secretory nerve and the stimulus is transmitted to the acting tissue-cells through the parasympathetic nervous system. Now we have arrived at the question whether hypoglycemia in general stimulates the secretion of the digestive juices or hyperglycemia inhibits it. It is desirable to solve this question without using insulin and adrenalin. For this purpose we introduced a gastric tube into the stomach, a duodenal tube into the duodenum and an another tube into the jejunum. After collection for a while (one hour) of the gastric and duodenal contents, 25 per cent solution of glucose in the proportion of one gram per kilogram of body weight was introduced into the jejunum and the collection of the digestive juices was continued. Hyperglycemia after resorption of glucose (ca. 15 minutes) stopped the pancreatic and biliary secretion almost entirely and the gastric contents became achlorhydric (before the administration of glucose free hydrochloric acid 64, total acidity 74 had been found). The hyperglycemia continued for about 1 hour and 45 minutes, the highest value being 0.151 per cent one hour after injection while at this point the secretion of the digestive juices stopped almost completely. Following the hyperglycemia a reactive hypoglycemia was evoked, the most significant figure of which being 0.059 per cent, 2 hours 15 minutes after the glucose administration, accompanied by a profuse secretion of the digestive juices. The same experiments were repeated and at the stage of complete cessation of the secretion by hyperglycemia (30 minutes after the glucose administration) we tried injections of 100 cc. of 0.2% hydrochloric acid or 3 cc. of ether into the duodenum resulting in a little or almost insignificant secretion of the pancreatic juice and bile.
From the foregoing experiments we have definitely proved that hypoglycemia in general stimulates the secretory nervous centrum and hyperglycemia inhibits it, and that the stimuli are transmitted through the parasympathetic nervous system to the reacting tissue-cells, while the inhibitory impulse is most easily transmitted through the sympathetic nervous system. This process is very natural and as well as important for the welfare of mankind. When too much nourishment is absorbed and hyperglycemia induced, the secretion of the digestive juices is arrested by inhibitory stimulus and further digestion and resorption are inhibited until the normal blood sugar level is restored. Hypoglycemia is accompanied by a sensation of hunger which causes the individual to take food eagerly and the digestion takes place promptly by profuse secretion of the digestive juices. Resorption accordingly occurs to meet the needs, while hyperglycemia causes a full and distended feeling at the epigastrial region which, in turn, causes the individual to refuse food. When however, foods are already present in the digestive tracts, no direct digestion and resorption occurs by inhibition of the secretion so long as hyperglycemia continues. Since hypo- and hyperglycemia induce humorally excitatory or inhibitory impulse to the secretory centrum, and from this centrum the stimuli are transmitted through the autonomic nervous system to the acting tissue cells, we call this process "THE HUMORO-NEURAL REGULATION OF THE SECRETION OF DIGESTIVE JUICES," thus establishing the theory advanced by the authors.