ever, carried it down promptly. These facts mean that the thoracic esophagus, which remained normally innervated, manifested secondary and primary peristalsis. Retention of the olive-shaped body in one place for some time fatigued the sensory nerve fibers and thus impaired the mechanism of the secondary peristalsis, but the primary peristalsis which required only intact motor nerves remained unaffected. In the cervical part, however, the innervation of the left side of the esophagus was greatly impaired or perhaps even abolished by the operation and the abnormal adhesions.

We see from the last mentioned results, therefore, that the secondary peristalsis is completely abolished, while the primary peristalsis is practically intact, which is in harmony with the above mentioned observations of Dr. Auer and myself of the effect of section of one vagus upon the secondary peristalsis of the esophagus.

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Peristaltic movements of the rabbit's cecum and their inhibition, with demonstration.

By **S. J. MELTZER** and **JOHN AUER.**

[*From the Rockefeller Institute for Medical Research.*]

The rabbit's cecum fills nearly one half of the abdominal cavity and is full of food, which has to get into it and leave it again by some moving force. Nevertheless we find in the literature practically no statement on the movements of that organ. There is good reason for it. When the abdominal cavity of a rabbit is opened the cecum as a rule shows no motion. We wish to report that according to our observations, that organ exhibits well marked and quite regular peristaltic movements; but these can be seen only in the normal animal. When a well fed rabbit is fastened on its back on a holder and the hair of the abdomen is removed, as a rule movements of the cecum can be seen sooner or later. The movements are well marked and characteristic in their appearance, and leave no doubt as to the organ in which they take place. We shall mention only a few details in this communication. As a rule, especially in well fed rabbits, the movements begin in the colon and travel towards the small gut, that is, they are antiperistaltic in

character. But frequently at the end of an antiperistalsis, after only a short interval, the wave returns and runs from the small gut towards the colon; in other words, the antiperistalsis is often followed by a peristaltic wave. The constriction is preceded by a bulging which is more marked than the former. The degree of the constriction (and bulging) is variable. Weaker waves sometimes do not finish the course. A complete course of a wave in one direction lasts from thirty to fifty seconds. The average rate of the movements is about one per minute, but the rhythm is far from being regular.

Some influences suppress cecal peristalsis. Ether applied through the nose stops the movements but they return in about a minute after the ether is removed. Pain, struggle and fright stop the movements; but they soon return again. The most striking effect, however, is the one caused by opening the abdomen: the peristaltic movements as a rule disappear completely and permanently.

What is the cause of this complete abolition of the movements? We thought it might be due to the strong and perhaps continued pain which the laparotomy causes, and tested this theory in the following way. The dorsal cord of a rabbit which showed well defined peristalsis of the cecum was cut at about the third vertebra. As a rule, in such experiments, the peristalsis was stopped for an hour and longer. After the peristalsis had been completely reestablished the abdomen was opened. The laparotomy could now cause no pain; nevertheless it completely abolished the peristalsis, as in a normal animal.

In the course of the latter series of experiments we made the observation that it was not necessary to open the peritoneal cavity to inhibit the movements. Cutting through the skin in the linea alba (in an animal with a cut cord) and dissecting it extensively from the muscles below was sufficient to abolish all cecal peristalsis. Furthermore, the movements returned as soon as the muscles were again covered by the skin, the cut edges of which were held together by clamps. It looked as if the cooling and drying due to the impact of the air upon the muscles above the cecum might have caused the suppression of the movements. But suspending the skin flaps and filling up the cavity above the muscles with warm physiological salt solution did not restore the cecal peristalsis. Furthermore extensive dissection of the skin of the lower

extremities also suppressed these movements. Finally immersion of the lower half of the animal in a warm saline bath inhibited the movements for twenty minutes and longer. When the peristalsis was reestablished it could then again be inhibited by taking the animal from the bath. All the various conditions referred to could affect the cecum only reflexly and not directly.

These experiments led to the inevitable conclusion that the warm or cool bath, and the dissections of the skin over the abdomen and the lower extremities, were various forms of more or less effective stimuli which caused reflex inhibition of the cecal movements. The path of these reflexes could run only through the dorsal cord below the cut. This conclusion was then tested by the effect which the complete destruction of that part of the cord would have upon the inhibitory reflexes. Cecal peristalsis is frequently abolished by such an operation, but reappears sooner or later, and then is often more marked than before the destruction. It was found that after the destruction of the cord the peristalsis of the cecum could not be inhibited by baths, dissections, etc. It was thus established that the cecum is under the control of inhibitory influences invested in the cord, which can be called into action by various peripheral stimulations. Such a stimulus is also exposure to the air of a part of the body which is usually more or less covered.

Under these circumstances we had reason to assume that the inhibitory influence of a laparotomy might be due also to such a stimulation and that it is in the nature of a reflex inhibition. But after further experimenting we found that opening of the abdomen, whether within a saline bath or not, unlike the other peripheral stimulations, inhibits greatly the cecal peristalsis: even after the destruction of the cord, only a few incomplete cecal waves appear after a laparotomy. We must then conclude that direct stimulation of the cecum caused by its exposure to abnormal conditions is capable of inhibiting its movements also directly. Laparotomy therefore abolishes the movements of the cecum by direct inhibition assisted probably also by reflex inhibition.

As to the cause of the movements of the cecum we found that the peristalsis ceased after cutting both vagi. Furthermore stimulation of the peripheral end of one vagus causes a tetanic contraction of the entire cecum, especially after destruction of the cord.

The latter effect is quite peculiar, however. The tetanus lasts only a short time, no matter how long or brief the stimulation may be. Moreover, the effect cannot be obtained by a second stimulation unless quite a long interval passes between the stimuli.

(Some of the above mentioned facts were demonstrated on an animal with destroyed cord.)

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Deglutition through an esophagus partly deprived of its muscularis, with demonstration.

By **S. J. MELTZER.**

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As a result of the experiments which Kronecker and I carried out about twenty-seven years ago, it appeared to be conclusively established that liquids are squirted down into the esophagus by the force of the contractions of the mylohyoid muscles and some muscles of the tongue, and that liquid thus projected reaches the cardia long before the arrival of the peristaltic wave. At that time the experiments were carried out on a human esophagus. About ten years ago in a series of experiments on the dog I found that our contention held good also for that animal. Cannon and Moser, however, who studied the esophagus by the fluoroscopic method, although confirming our conclusions for the human being, state that "in the dog and cat but little variation was seen in the swallowing of liquids and solids." Recently Schreiber stated that even in the human being, liquids, just like solids, are not squirted down but are carried by the muscles of the mouth and tongue to the pharynx, whence they are conveyed further into the esophagus by the contractions of the constrictors of the pharynx and are finally transported into the stomach by the peristaltic movements of the esophagus. In other words, liquids are also slowly pushed forward through every section of the path of deglutition by the contraction of the muscle fibers of that section; there is no part of that long path through which liquids are thrown or squirted.

I do not intend to enter into an analysis of the experiments and arguments upon which Schreiber founded his views. The object of