It is suggested that, as a result of the markedly restricted circulation with particle-free perfusates, abnormal conditions develop which alter the capillary wall and bring about excessive capillary permeability. This would account for the early appearance of edema with such solutions. The widespread distribution of particle-containing perfusates approached a more normal circulation in the capillary bed and was thereby instrumental in pronouncedly delaying the onset of edema.

11378

Attempt to Produce Experimental Cardiospasm in Dogs.*

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In the clinical condition of cardiospasm food does not pass readily from the esophagus into the stomach although at autopsy the cardia does not exhibit hypertrophy or stenosis.[1] Postmortem studies have shown degeneration of the vagi[2, 3] and loss of ganglion cells[4–9] from the myenteric plexus of the cardia. Failure of the normal receptive relaxation of the cardia in response to the swallowing of food is cited by Hurst[10] as the cause of cardiospasm. Cannon[11] demonstrated that this mechanism is abolished in cats following section of the vagi in the neck. By cutting the vagi in the thorax Knight[12] was able to reproduce the X-ray appearance of cardiospasm in anesthetized cats. In the course of a study of the motility of the

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1 Sturtevant, M., *Arch. Int. Med.*, 1933, **51**, 714.

2 Heyrovsky, H., *Arch. f. klin. Chir.*, 1913, **100**, 703 (Quoted by Lendrum, *loc. cit.*).

3 Loeper, M., and Forestier, J., *Aech. d. mal de l'app. digestif.*, 1921, **11**, 306. (See Lendrum, *loc. cit.*)

4 Hurst, A. F., and Rake, G., *Quart. J. Med.*, 1930, **23**, 491.

5 Cameron, J., *Arch. Dis. Childhood*, 1927, **2**, 358.

6 Beattie, W. J. H. M., *St. Bartholomew's Hosp. Rep.*, 1931, **64**, 39.

7 Mosher and McGregor, *Ann. Otol. Rhin. and Laryng.*, 1928, **37**, 12.

8 Lendrum, F. C., *Arch. Int. Med.*, 1937, **59**, 474.

9 Hara, H. J., *California and Western Medicine*, 1929, **30**, 390.

10 Hurst, A. F., *J. A. M. A.*, 1934, **102**, 582.

11 Cannon, W. B., *Am. J. Physiol.*, 1904, **19**, 436.

12 Knight, G. C., *Brit. J. Surg.*, 1934, **22**, 155.

cardia in dogs Zeller and Burget[13] performed thoracic vagotomy in nine animals; subsequent studies without anesthesia revealed no loss of tonus or failure of relaxation. They suggest that vagal impulses may be transmitted to the cardia through fibers which travel in the wall of the esophagus.

The present report deals with an attempt to interrupt any such fibers by combining an encircling incision through the outer coats of the esophagus with bilateral thoracic vagotomy.

Since anesthetics interfere with visceral reflexes, a modification of the method outlined by Burget and Zeller[14] for recording motility in nonanesthetized dogs was used. Employing this method, the dogs were subjected to preliminary esophagostomy in which the esophagus was brought to the exterior in the midline below the cricoid cartilage. These animals did not regurgitate nor did they lose any considerable amount of food during the act of swallowing. Following recovery the dogs were trained to lie quietly on a table while motility studies were made. Three rubber balloons attached to soft rubber catheters were passed down the esophagus, the lowest being lodged in the cardia, the second in the lower esophagus, and the uppermost a short distance below the esophageal fistula. The 2 lower balloons were connected to sensitive Becker tambours. The uppermost balloon was connected by a T-tube with a rubber bulb and with a mercury manometer. By means of this arrangement stimulation of the esophagus could be effected and recorded. Momentary distension of the uppermost balloon resulted in an almost immediate relaxation of the cardia, which definitely preceded the passage of a peristaltic wave over the middle balloon.

When the dogs were well trained the interruption of nerve pathways in the thorax was attempted. Under nembutal anesthesia and artificial respiration by tracheal catheter, the thorax was entered on the left side, both vagi and the communicating branch were cut about 4 cm above the diaphragm, and the outer coats of the esophagus were cut along its entire circumference at the same level, laying bare a band of white submucosa 1 cm wide. In 5 dogs this procedure was varied by doing the operation in 2 stages, first girdling the esophagus, then reëntering the thorax a few weeks later to cut the vagi.

After operation the animals were observed for difficulty in swallowing, presence or absence of cardiac relaxation, and change of

[13] Zeller, W. E., and Burget, G. E., *Am. J. of Digest. Dis. and Nutrition*, 1937, **4**, 113.

[14] Burget, G. E., and Zeller, W. E., PROC. SOC. EXP. BIOL. AND MED., 1936, **34**, 433.

body weight. The dogs subjected to simple girdling of the esophagus alone did not experience difficulty in swallowing, and receptive relaxation of the cardia was present.

All the dogs subjected to the combined operation of girdling of the esophagus and thoracic vagotomy showed marked loss of weight and great difficulty in swallowing. A dog when given a half can of food would gulp it down, immediately begin to strain and extend its neck, and make swallowing movements and soon return practically all of the food as a mucous-coated, sausage shaped mass. The regurgitated food did not change the color of blue litmus paper. By repeated attempts the dog might dispose of half a can of food within 10 minutes. In this group of dogs 5 showed complete absence of relaxation of the cardia in all motility records taken postoperatively. Two dogs were too restless following the operations to permit taking satisfactory records, 2 revealed occasional slight relaxation in response to strong stimulation, and one exhibited relaxation which was indistinguishable from that demonstrated in preoperative records. In spite of recorded relaxation these last 3 animals exhibited marked difficulty in swallowing and rapid loss of weight. Of the 12 dogs used 2 died of perforation of the esophagus within 3 days following the thoracic operation. The results are summarized in Table I.

TABLE I.

Operation	No. of dogs studied	No. of dogs showing difficulty of swallowing	No. of dogs in which relaxation could be recorded
Encirclement of esophagus	5	0	5
Combined operation	10*	10	3†

*In 2 of these balloon records could not be obtained.
†Two of the 3 exhibited only occasional slight relaxation in response to strong stimulation.

On postmortem examination the 2 dogs with perforation of the esophagus showed mediastinitis. One died 13 days after operation with hemorrhages of undetermined cause into the stomach and small intestine. In this and other dogs sacrificed at intervals of 34 to 84 days after operation, the esophagus was found not to be inflamed, dilated or constricted. In every case one or 2 fingers could be passed easily through the cardiac orifice into the stomach.

The failure to demonstrate uniformly a complete loss of relaxation in 3 of the dogs is not readily explained. It may be that all vagal pathways concerned in the relaxation of the cardia were not severed. It is possible that the motility studies are capable of showing a relaxation of the cardia which is not sufficient in degree to allow the free passage of food into the stomach.

Summary. A combined operation of bilateral vagotomy 4 cm above the diaphragm and girdling of the esophagus at the same level is described as a means of producing in dogs an experimental condition comparable to clinical cardiospasm. In the majority of cases the regurgitation of food can be shown to be accompanied by a failure of receptive relaxation of the cardiac orifice of the stomach. Since neither bilateral vagotomy in the thorax[14] nor girdling the esophagus above the diaphragm is sufficient in itself to produce these results, it may be concluded that some but not all of the fibers responsible for receptive relaxation of the cardia of the dog course downward within the wall of the esophagus.

11379

Failure of Maternal Vitamin A Depletion to Produce Congenital Anomalies in the Young of Rats.

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Attention recently has been directed to possible dietary causes of congenital anomalies by Hale's observations[1, 2, 3] on the occurrence of microphthalmia, hare lip, cleft palate, and the failure of the kidneys to leave their embryonic position in the young of vitamin A-deficient sows. Others who have investigated reproduction in vitamin A-deficient hogs have reported abortion, resorption or the birth of dead fetuses. In some instances prolonged labor was observed, but congenital anomalies in the young were not described.[4, 5]

Hart, Meade and Guilbert[6] made no mention of congenital defects in calves born to cows showing night blindness at the time of parturition, nor were anatomical abnormalities recorded by Hart and Miller[7] among lambs from ewes kept on vitamin A-low rations for nearly a year and night blind at the time of lambing.

1 Hale, Fred, *J. Heredity*, 1933, **24**, 105.

2 Hale, Fred, *Am. J. Ophthal.*, 1935, **18**, 1087.

3 Hale, Fred, *Texas State J. Med.*, 1937, **33**, 228.

4 Hughes, J. S., Aubel, C. E., and Lienhardt, H. F., *Kansas Agric. Exp. Sta. Tech. Bull.*, 1928, **23**, 1.

5 Hughes, E. H., *J. Agric. Res.*, 1934, **49**, 943.

6 Hart, G. H., Mead, S. W., and Guilbert, H. R., PROC. SOC. EXP. BIOL. AND MED., 1933, **30**, 1230.

7 Hart, G. H., and Miller, R. F., *J. Agric. Res.*, 1937, **55**, 47.