of HCl as reported by Ivy and Oldberg,[4] it would seem that hydrochloric acid plays a very insignificant rôle in the emptying of the human gall bladder.

Finally, a substance has been found—petrolatum—which separates the action of the gall bladder musculature from that around the outlet of the common duct. In the 2 cases in which this inert mineral oil was injected into the duodenum, an initial relaxation of the gall bladder ensued, followed by increased tonus but no diminution of size. Subsequently when egg yolk was injected, the gall bladder again contracted (as evidenced by the shape of the cholecystograms), but was again unable to discharge its contents—due, presumably to a spastic closure of the outlet of the common duct induced by the presence of petrolatum. But when the patient was given a coarse meal which scoured the oil out, the gall bladder emptied about half of its contents. It would seem, therefore, that by the use of petrolatum we had reproduced the conditions recorded spontaneously in a previous case of hour-glass gall bladder in which the biliary vesicle could be induced to contract but the sphincter remained closed.[5]

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Physiological Effects of Temporary Occlusion of the Coronary Vessels.

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The following experiments were conceived by Dr. Andrew C. Ivy and myself in an effort to explain the acute effects of sudden occlusion of a coronary artery. The assistance of Dr. Ivy and Mr. Leuth has been essential to the success of these experiments. This work may be divided into 3 phases:

EXPERIMENTS OF SERIES I.

Method: Under ether anesthesia and artificial respiration the chest is opened in the 5th left intercostal space. Through a small incision in the pericardium a ligature is passed around the *ramus descendens* anterior sinister branch of the left coronary artery. Without tying, the 2 ends of the ligature are passed through a

[4] Ivy, A. C., and Oldberg, Eric., *Ibid.*, 1928, xxv, 251.

[5] Boyden, E. A., *Ibid.*, 1927, xxv, 99.

flanged glass tube. With a purse string suture the proximal end of the tube is sutured into the pericardium at the same time closing the incision in the pericardium. The proximal end of the tube is sutured to the chest wall and the incision closed with practically no pneumo-thorax remaining. After 3 to 4 hours the dog has completely recovered from the anesthesia and is apparently little harmed by the operation. By fixing the external portion of the glass tube, traction on the ligature compresses the included artery, vein and possibly nerves without displacing the heart. The effects of this procedure are.

1. Observation—the glass tube and ligature had no evident effect on the heart. Pain is caused by traction. The degree varies in different animals. Almost the moment the traction is released the animal becomes quiet and apparently normal. Pain does not occur when only muscle and pericardium are included in the ligature.

2. Salivation—which is an indication of nausea in the dog, was present 3 times, one dog vomited.

3. Respiration—is violent and irregular as would be expected in pain.

4. Dilatation of the heart was present 4 times to a marked degree. This dilatation is definitely limited by an intact pericardium. The pericardium is tense and when opened, the heart bulges through.

5. Electrocardiograms—During traction show premature contractions, usually of ventricular origin, also of auricular origin. Paroxysmal tachycardia of ventricular origin has been observed. Complete cardiac standstill has been observed varying from 1 to 5 seconds in duration in 3 out of 4 dogs. There is an increase in the amplitude of both the R and T waves. Inversion of the T has been observed in only one dog but it rises quickly from the down stroke of the R as in human electrocardiograms.

EXPERIMENTS OF SERIES II.

A. After section of the vagus nerves, in one dog pain occurred when only the vein was included in the ligature. Great cardiac dilatation occurred.

B. The left stellate ganglion has been removed in 3 dogs. One to 3 weeks later ligatures around the artery failed to produce pain. Salivation was marked in one.

EXPERIMENTS OF SERIES III.

Method: Under Barbital anesthesia and artificial respiration, the chest was laid open exposing the heart. Myocardiograph levers

were attached to the right ventricle and right auricle and lead to tambours writing on a smoked drum. Blood pressure was recorded directly from the right carotid artery. The coronary artery is ligated and the ligature runs through a glass tube which is inserted through the chest wall exactly as in the preceding experiment. In this experiment direct observation of the heart is possible, also direct record is made of the auricular and ventricular contractions and simultaneous blood pressure record.

Traction with compression of the enclosed artery and vein produces cyanosis of the ventricle, increase in size of the vein with definite anemia of part of the ventricle, closely followed by a definite increase in volume of the ventricle, later of the auricle. There is a definite fall of blood pressure amounting from 30 to 50 mm. of Hg. Removal of the left stellate ganglion in 2 dogs had no evident effect. After section of the vagi there is no fall in blood pressure.

Summary: 1. Compression of the coronary vessels and immediately adjacent tissue as described caused pain without exception, sometimes salivation, vomiting in one case, a disturbance of respiration, "acute dilatation" of the heart and various changes in the electrocardiogram. Symptoms have not been produced by localized compression and tearing of the myocardium or pericardium. This may be due to a high threshold of problematical pain endings in the normal cardiac muscle and pericardium.

2. Severance of the vagi has not interfered with transmission of pain impulses in 2 dogs.

3. Removal of the left stellate ganglion has prevented the transmission of pain impulses in 2 dogs but salivation occurred in one of the 2.

4. A prompt fall of blood pressure occurred in all acute experiments on compression of the coronary vessels as described. Section of the vagi usually prevented this fall in blood pressure.

5. Fall of blood pressure, cardiac dilatation and cardiac irritability are increased by moderate cyanosis (anoxemia).