explored every 2 weeks up to 6 weeks and then once a month until either an ulcer was found or they died from some other cause. Sixteen of the 26 died from extraneous causes at an average of 26 days postoperative without ulcer formation.

Three of the 10 dogs that formed ulcers died before any attempt of cure could be made; one died from hemorrhage, and 2 from hemorrhage with partial biliary obstruction. In the other 7 the bile, pancreatic juice, and duodenal secretions were poured back over the area of ulcer formation as soon as it was discovered. In order to do this the lateral anastomosis was taken down and an end-to-side union made between the duodeno-jejunal loop and the stomach. In 4 cases the ulcer completely healed, in 42, 56, 61, and 83 days respectively. In 2 it was only partially healed when the dogs died, one from distemper at 19 days, and the other from partial biliary obstruction with jaundice at 153 days. The 7th dog showed no disposition to heal and died from hemorrhage on the 13th day following the second operation. In 2 of the dogs where the ulcer had healed completely, the digestive juices were again short-circuited. In the 1st dog the ulcer reformed, perforated, and caused the death of the dog from peritonitis on the 12th postoperative day. The second attempt was a failure due to a faulty suture line, causing the death of the dog on the 4th day after operation. The general condition of the dogs remained excellent until an ulcer appeared. From this time on they rapidly lost weight and became anemic, but gained weight during the healing period after the second operation.

6102

The Etiology of Duodenal Ulcers.

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Since the original work of Mann and Williamson[1] much has been written concerning the experimental production of duodenal ulcers by depriving the duodenum of its normal alkalinity. It, therefore, becomes of interest to know if any one of the 3 secretions, bile, pancreatic juice, or intestinal juices, is specifically responsible for protection against ulcer formation, or whether the presence of all of them is necessary.

[1] Mann, F. C., and Williamson, C. S., *Ann. Surg.*, 1923, **77**, 409.

In an attempt to determine this point 3 series of experiments were done. In the first series 5 operations were performed under aseptic technic and the common bile duct isolated, tied, and divided in each case. Following this a cholecyst-enterostomy was performed at a point on the small bowel about 18 inches below Treitz's ligament, thereby excluding the bile from the duodenum and draining it into the jejunum at this point. The anastomoses and closures were done with silk. Two of these 5 animals developed an acute duodenal ulcer at 76 and 119 days postoperative respectively. In each case the ulcer was situated exactly at the pyloric ring and was about 3 mm. in diameter. Both died of hemorrhage into the bowel without warning and the ulcer was only discovered at autopsy. Pathologically these ulcers were very different from chronic ulcers produced by duodenal drainage. They were smaller, more punched out, showed no sign of secondary infection, had hemorrhagic bases ulcerating into a vessel in each case, and presented no evidence on the serosal surface by which ulcer formation could have been predicted. Microscopically, they showed very little infiltration and no scar tissue formation. Both animals were in good general condition at the time of death. The 3 others were well nourished and showed no sign of ulcer formation at the date when they were sacrificed, 234, 236, and 239 days postoperative respectively.

Microscopic sections taken of the liver and gall-bladder in this series showed slight low grade infection of the gall-bladder but no cholangeitis. It was felt that this presented an interesting point, in view of the high percentage of infection reported clinically following cholecyst-enterostomy. It is possible that our good results were due to the small openings used in our anastomoses, for the average measurement of these openings at autopsy was only 2.3 mm.

In a second series of experiments an effort to determine the effect of loss of pancreatic juice was made. The accessory pancreatic duct was located, ligated, and divided, and the main duct was isolated and transplanted into the jejunum 18 inches below Treitz's ligament. The implantation of the duct and all closures, both of bowel and abdominal wall, were done with silk. These dogs were then allowed to go for an average of 123 days, being fed the usual laboratory diet. They were explored every 3 weeks during this period and at no time was there any evidence of ulcer formation. Their nutrition and condition in general remained excellent.

The third series of experiments was performed on these same animals. It consisted of ligation and division of the common bile duct with concomitant cholecyst-enterostomy about 2 inches below the

point where the pancreatic duct had already been transplanted. This deprived the duodenum of both bile and pancreatic juice, leaving it only duodenal juices for protection against the acid gastric secretion. The dogs were now allowed to go on for an average of 78 days, during which period they were explored several times with no evidence of ulcer formation. At the end of this time when they were sacrificed their nutrition was good, there was no anemia, and no damage to the mucosa of the duodenum.

The number of these experiments is too small and the period of time too short to draw any definite conclusions, especially in view of the inconstant results, but they suggest that the bile is the most important of the 3 factors.

6103

A New Method for Determining the Fragility of Red Blood Cells.

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Prevailing methods for the determination of the fragility of erythrocytes are based upon the theory of their hemolytic stability when brought into contact with chemicals such as saponin and bile salts, with specific sera, or with hypotonic salt solutions. Theoretical as well as practical considerations have directed the development of these studies toward improving the technique for determining the resistance of the red blood cells to solutions containing different concentrations of various salts. Of the many variations in the original method of Ribierre,[1] that of Simmel,[2] or one of its modifications,[3] appears to be the best. However, the necessity of freshly prepared hypotonic salt solution of very exact concentrations, together with the labor in using the counting chamber and the necessity for setting up a control test with a known normal blood at each observation, are definite disadvantages.

We have devised a fragility test in which the difficulties mentioned are largely eliminated. The testing of the relative fragility of the

[1] Ribierre, P., *L'hemolyse et la mesure de la résistance globulaire; application à l'étude de la résistance globulaire dans l'ictère. Thèse de Paris,* 1903, No. 154.

[2] Simmel, H., *Arch. f. klin. Med.,* 1923, **142**, 252.

[3] Waugh, R. T., and Chase, W. J., *J. Lab. and Clin. Med.,* 1928, **13**, 873.