

STUDIES ON THE PHYSIOLOGY OF GASTRO-ENTEROSTOMY

I. THE REGURGITATION OF INTESTINAL CONTENTS IN NORMAL DOGS
AND DOGS WITH POSTERIOR GASTRO-ENTEROSTOMY

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Different investigators have in the past few years reported finding duodenal juices in the normal stomach, especially when the acidity there was of fair degree. Boldyreff (1) studied the circumstances by which duodenal contents might be expected to be found in the stomach. He found that this reflux took place when the acidity of the stomach was higher than the duodenal mucosa could tolerate, a mechanism which tended to keep the acidity of the stomach at a low level. He called this mechanism the self-regulation of the acidity of the stomach contents. His work was done on dogs with gastric fistula. Morse (2) found that regurgitation often occurred in anesthetized pithed dogs when the acidity reached 0.2 per cent and nearly always with acid of higher concentration. He also found that the higher the concentration (0.1 to 0.5 per cent) of acid the greater the regurgitation. The rate of emptying of the stomach decreased with the increase of acidity. Hicks and Visser (3) introduced by means of a tube 150 cc. of 0.5 per cent HCl into the stomach of dogs and noted a regurgitation in fifteen minutes in 30 per cent of the tests and in thirty minutes in 45 per cent.

They state that the introduction of 0.4 per cent HCl in a human subject showed no regurgitation at the end of twenty minutes. A psychic secretion averaging 32.6 cc. (acidity 0.411 per cent) obtained in an individual with a gastric fistula caused a reflux in 40 per cent of ten trials. Rehfuss and Hawk (4) assert that the introduction of 0.5 per cent HCl in a human subject caused regurgitation of the alkaline intestinal secretion. Moppert (5) reported spontaneous reflux of bile in 72 per cent of cases examined using the Einhorn thread. Jarno (6) found regurgitation in the human stomach after introduction of relatively weak acid solution, 0.08 per cent.

We thought it worth while to repeat Boldyreff's experiments on normal dogs, using a stomach tube for introducing the acid and aspirating samples and then to make a similar study of these animals after gastro-enterostomy to learn the effect on the normal mechanism of gastro-enterostomy. We had no difficulty whatsoever in using the stomach tube. After the first few times the tube was introduced the dogs showed no signs of discomfort and did not struggle. We were surprised to see the ease with which the test could be carried out.

Dogs of average size and in good condition were chosen. They were kept in the laboratory during the period of normal test but were given exercise outside every other day. They received no food for twenty-four hours previous to the test but were allowed water at all times. One hundred to 150 cc. of 0.5 per cent HCl were given with a stomach tube, the dog was then allowed to get on his feet and walk about for a minute or two, giving opportunity for the acid introduced to mix with the stomach contents. A sample was then obtained by aspiration and titrated. The presence of water, if any was in the stomach, was shown by this titration. A second sample was taken fifteen minutes after introduction of the acid, another in thirty minutes, etc., until the acidity was reduced to 0.1 to 0.2 per cent, or the stomach empty. The bile coloration was used as an indication of a reflux from the duodenum.

Our results on the normal dogs confirm the findings of Boldyreff. The average length of time for reduction of the acidity to 0.1 to 0.2 per cent was in our experiments seventy-five minutes to ninety minutes. The first appearance of bile varied considerably with different dogs and different experiments. It was sometimes present in fifteen minutes, often in thirty minutes and a few times was delayed for an hour.

Paterson (7) demonstrated the presence of bile in the gastric contents by Gmelin's reaction in 73 per cent of his patients after gastro-jejunostomy. He also stated that the total acidity was reduced 30 per cent, partly due to the neutralization of the acidity by the bile and pancreatic secretion and partly to earlier stimulation of the pancreas bringing about an earlier diminution of the gastric secretion (8). Lemon (9) found a reduction of the acidity after gastro-jejunostomy of 39 per cent total and 46 per cent free. A study of two hundred cases was made and the reduction ascribed to flowing into the stomach of the alkaline secretion of the duodenum.

The gastro-enterostomy opening in our dogs was made $2\frac{1}{2}$ to 3 cm. long on the posterior wall of the antrum of the stomach near the pylorus. The opening in the duodenum was made at the tail of the pancreas.

Care was exercised in feeding for a few weeks to permit complete healing about the stoma. In no case were there untoward symptoms following the operation. All the animals made a speedy recovery and soon regained any loss of weight. Allowing two or three weeks for recovery the tests were again made as before the operation. Bile was often present in the first sample, the one taken almost at once after the acid was given. It was regularly present after fifteen minutes and the process of partial neutralization was carried on with corresponding rapidity. After thirty to forty-five minutes the acid was reduced to 0.1 to 0.15 per cent and the stomach nearly empty.

Whether or not after gastro-enterostomy the acid brings about an earlier stimulation of the pancreatic secretory mechanism or the mechanism for regurgitation is rendered more efficient, that is, the stoma permits a freer flow of intestinal juices into the stomach, we are unable to say. Cannon (10) has shown that the stoma may act as a valve, letting contents pass into the stomach but closed in the other direction, especially when the stomach is distended. Since there was a shorter emptying period in our experiments after gastro-enterostomy it must be accounted for in one of two ways. Either the earlier neutralization allowed passage sooner through the pylorus or a part of the contents passed through the gastro-enterostomy opening. These questions are being investigated.

The manner in which the duodenum forces back its contents as reported by Boldyreff (1) is by antiperistalsis. Hicks and Visser (3), however, claim not to have seen any antiperistaltic movements in their experiments but rather constriction bands. This point will be reported on with further studies in this field.

SUMMARY

1. The alkaline juices of the duodenum are regularly regurgitated into the stomach of the dog within thirty to forty-five minutes after the introduction of 100 to 150 cc. of 0.5 per cent HCl.
2. After introduction of 100 to 150 cc. of 0.5 per cent HCl, the acidity of the stomach contents is reduced to 0.1 to 0.15 per cent in seventy-five to ninety minutes and the stomach empties at a rate in proportion to the rate of regurgitation of duodenal juice.
3. In dogs with posterior gastro-enterostomy duodenal regurgitation takes place within fifteen minutes after introduction of 100 to 150 cc. of 0.5 per cent HCl and the acidity of the stomach contents is reduced to 0.1 to 0.15 per cent in thirty to forty-five minutes.

Experiments on a number of animals gave concordant results. Typical experiments on two animals before and after posterior gastro-enterostomy are shown in the table.

TABLE I
150 cc. of 0.5 per cent HCl introduced

TIME INTERVALS	NORMAL		AFTER GASTRO-ENTEROSTOMY	
	Total acidity per cent	Character of specimen	Total acidity per cent	Character of specimen
Dog 7				
<i>minutes</i>				
2	0.4466	Clear	0.4922	Turbid
15	0.4102	Clear	0.2918	Bile ++
15	0.3646	Bile +	0.2553	Bile ++
15	0.3554	Bile +	0.1824	Bile +++
15	0.3007	Bile ++	0.1185	Bile +++
15	0.1824	Bile +++		
Dog 4				
2	0.4375	Clear	0.4740	Bile, trace
15	0.3646	Bile, trace	0.3098	Bile ++
15	0.3281	Bile, trace	0.1454	Bile +++
15	0.2644	Bile ++	0.06	Bile +++
15	0.2553	Bile ++		
15	0.1915	Bile ++		

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