

Effect of Truncal, Selective and Highly Selective Vagotomy on Gastric Emptying and Intestinal Transit of a Food-Barium Meal in Man

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BOTH TRUNCAL VAGOTOMY¹⁰ and bilateral selective vagotomy,^{12,18} when used alone, have produced gastric stasis in man.^{4,11} This is not surprising, since both procedures effect the entire stomach,²⁵ including the antrum. In consequence, the addition of a drainage procedure is necessary. However, the combination of complete gastric vagotomy with pyloroplasty or gastrojejunostomy leads to abnormally-rapid gastric emptying,^{6,7,20,22,25} which in turn may produce side-effects such as dumping and diarrhea.^{17,22,23}

Highly selective vagotomy (HSV) is confined to the parietal cell mass.^{1,19} The antrum remains innervated, eliminating the addition of a drainage procedure^{1,19} and side-effects are much reduced.^{16,20} This study compares gastric emptying in patients after HSV with gastric emptying in patients before operation and in patients after truncal or selective vagotomy with pyloroplasty. The main questions to be answered were: first, was there evidence of gastric stasis after HSV, and, second, was the pattern of gastric emptying and small bowel transit closer to the preoperative pattern after HSV than after vagotomy with pyloroplasty?

Method

Patients

Thirteen patients with duodenal ulceration (DU), without clinical or radiologic signs of pyloric stenosis, were studied before operation. Patients who were studied after vagotomy were in good health (nearly all in Visick I and II¹³), 1 to 3 years after operation, and in each the

vagotomy had been complete in insulin testing¹⁵ in the early postoperative period.

All the patients were men, with the exception of two women in the selective vagotomy group and one woman in the HSV group. Twelve patients had undergone truncal vagotomy and pyloroplasty (TV + P); 10 had bilateral selective vagotomy and pyloroplasty (SV + P), and 14 underwent highly selective vagotomy without drainage (HSV). The pyloroplasty was of the Heinecke-Miculicz type in each case. The mean (± 1 SE) ages of the patients were 45.1 \pm 3.7 (DU), 49.8 \pm 3.5 (TV + P), 44.8 \pm 2.4 (SV + P), and 44.5 \pm 2.5 years (HSV). Mean weights were, respectively, 67.3 \pm 2.3 Kg. (DU), 68.2 \pm 1.8 (TV + P), 62.9 \pm 2.7 (SV + P) and 68.3 \pm 1.9 Kg. (HSV).

Meal

The meal consisted of two slices of toast, one ounce (28 Gm.) of butter, two scrambled eggs, 170 ml. of tea with milk and one teaspoonful of sugar, 30 ml. of 'Ray-bar' and 30 ml. of water. These ingredients were homogenized in a blender for 10 minutes. The resulting meal was semi-fluid in consistency and tasted surprisingly pleasant, like a rather chalky cake-mix. It was served warm, and eaten with a spoon because it was too thick to drink.

Procedure

The test began at 6 p.m., after the patient had fasted from lunchtime, about 1 p.m. First, a plain X-ray film of the abdomen was taken. Then the patient sat upright in a chair, and ate the meal in the course of 5 to 10

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minutes. Further abdominal radiographs were taken, 15, 30, 45, 60, 90, 120 and 150 minutes from the start of the meal, with the patient lying prone on the X-ray table. In the intervals between exposures, he sat in a chair, or strolled about the X-ray Department.

Assessment

The films were assessed by an experienced radiologist, who was unaware of the group to which the patient belonged. He was asked to answer three questions: (1) Which was the first film which showed the start of gastric emptying (*i.e.* the presence of barium in the duodenum or beyond). (2) When was the stomach completely empty? (apart perhaps from the merest traces of barium clinging to the gastric mucosa). (3) When did the head of the meal reach the colon?

Statistics

Differences between groups were analyzed by means of the Mann-Whitney test²¹ for non-parametric data.

Results

Time Interval before the Start of Gastric Emptying.

Gastric emptying had begun by the time the 15-minute film was exposed in all the patients who had undergone TV + P or SV + P, but in only 10 of the 13 preoperative DU patients and 12 of the 14 patients after HSV (Fig. 1). These differences are not statistically significant. By 30 minutes, gastric emptying had begun in all patients.

Time Required for Stomach to Empty Completely.

Gastric emptying was significantly faster in patients who had undergone TV + P ($p < 0.002$) or SV + P ($p < 0.002$) than in preoperative DU patients. Gastric emptying was also significantly faster after TV + P than after HSV ($p < 0.002$), and significantly faster after SV + P than after HSV ($p < 0.01$). There was no

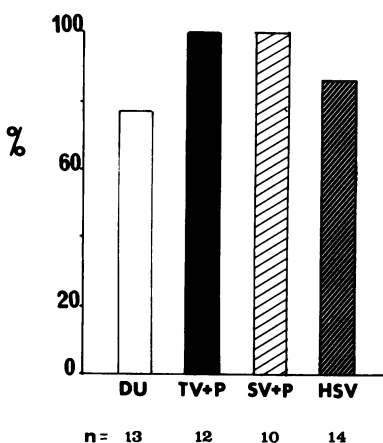


FIG. 1. In most patients, barium was visible in the duodenum or beyond at 15 minutes. The start of gastric emptying is slightly faster in patients after TV + P and SV + P than in preoperative DU patients or patients after HSV. By 30 minutes, gastric emptying had begun in all patients.

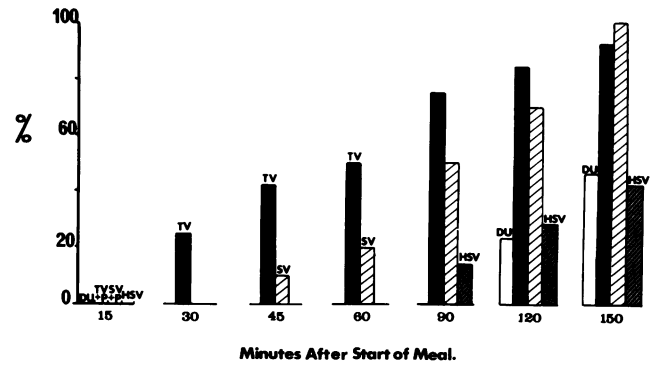


FIG. 2. Patients after truncal vagotomy and pyloroplasty (TV) had significantly faster ($p < 0.002$) gastric emptying than had either patients with duodenal ulcer before operation (DU) or patients who had undergone highly selective vagotomy (HSV). Though gastric emptying in the selective vagotomy-pyloroplasty group (SV) was slightly slower than in patients after TV + P, it was significantly faster than in DU patients ($p < 0.002$) or HSV patients ($p < 0.01$). The pattern of gastric emptying after HSV was similar to that observed in preoperative DU patients.

significant difference between the rates of gastric emptying in DU and HSV patients (Fig. 2). For example, 90 minutes after the meal, the stomach was completely empty in none of the 13 DU patients, nine of 12 patients after TV + P, five of ten patients after SV + P, and two of 14 patients after HSV.

Time Required for the Head of the Meal to Reach the Cecum.

Small bowel transit, as judged by the time required for the head of the meal to reach the colon, was significantly faster in patients after TV + P ($p < 0.002$) and SV + P ($p < 0.002$) than in preoperative DU patients (Fig. 3). Small-bowel transit was also slightly faster in HSV patients than in preoperative DU pa-

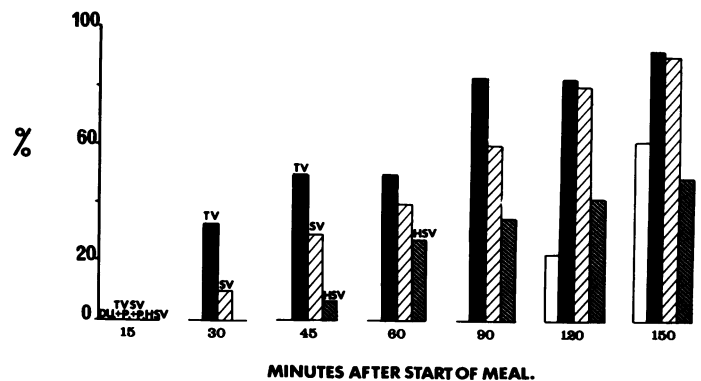


FIG. 3. Transit of the head of the meal through stomach and small intestine was significantly faster after truncal vagotomy-pyloroplasty (TV) than before operation (DU: $p < 0.002$), or than after highly selective vagotomy (HSV: $p < 0.05$). Similarly, gastro-intestinal transit was significantly faster in the selective vagotomy-pyloroplasty group (SV) than in preoperative DU patients ($p < 0.002$). The HSV and DU groups of patients did not differ significantly.

tients, but the difference was not statistically significant. Barium reached the colon significantly faster after TV + P than after HSV ($p < 0.05$), but the difference between the SV + P and HSV groups was not very significant ($p < 0.1$). For example, 45 minutes post-cibum the head of the meal had reached the colon in none of the preoperative DU patients, six of 12 TV + P patients, three of 10 SV + P patients and one of 14 HSV patients. Ninety minutes after the meal, barium had reached the colon in none of the DU patients, 10 of 12 TV + P patients, six of 10 SV + P patients and five of 14 HSV patients.

Discussion

A radiologic method such as this is a relatively crude way of investigating gastric emptying. It is capable only of demonstrating the existence of large differences between groups of subjects. One cannot, for example, state that the stomach is 35% empty or 80% empty. However, certain definite statements can be made. One can say that gastric emptying has started or that it has not; that the stomach is completely empty or that it is not; and that the head of the meal has reached the colon or that it has not. Emptying of the thick food-barium paste is likely to give a better estimate of the emptying of a normal meal than would barium alone.

It is assumed, on the basis of previous work by others,¹⁴ that gastric emptying is normal, or at least not slower than normal, in patients with duodenal ulcer who do not have clinically-manifest pyloric stenosis.

The results which we have obtained are in accord with those of previous workers^{6, 22, 23, 26} who found that gastric emptying of fluids was significantly faster after truncal or selective vagotomy with a drainage procedure than in patients with duodenal ulcer before operation. They are also in agreement with reports that gastric emptying of fluids,⁵ and of food-and-barium,²⁴ is not delayed after HSV. Our results are not in agreement with the report by Buckler² that gastric emptying was delayed after truncal vagotomy and pyloroplasty, nor with that of Cowley *et al.*⁸ who found that gastric emptying was normal after truncal vagotomy and pyloroplasty. Buckler² and Cowley *et al.*⁸ used a test meal of solid food, which may explain why gastric emptying in their patients was slower than in our patients after TV + P or SV + P, in whom the test meal was semi-fluid. The posture adopted by the patients during the test may also provide an explanation for the differing results, because Cowley's *et al.*⁸ patients were kept in a recumbent position throughout the test, whereas our patients sat in a chair or walked about except when radiographs were being taken. According to the work of McKelvey *et al.*,^{22, 23} posture does not exert an important influence on gastric emptying in the intact individual,

but after vagotomy with a drainage procedure it assumes great importance. Gastric emptying is retarded if the patient lies supine and is rotated towards the left, whereas emptying is precipitate if the patient assumes the upright posture. These findings of McKelvey *et al.*^{22, 23} apply only to fluids, but they are probably relevant to the emptying of normal meals. For example, a normal dinner consists of fluids (aperitif, soup) followed by solids and semi-solids (meat, gravy and potatoes), followed by solids with hypertonic liquid (fruit salad with syrup and ice-cream), followed by more fluids (coffee). The conclusions of Cowley *et al.*⁸ that gastric emptying is within the normal range after TV + P are also difficult to accept because it is known that 10 to 30 per cent of patients experience early dumping in the first year after TV + P or SV + P,¹⁶ which strongly suggests that their gastric emptying is abnormally rapid. Finally, after the demonstration by Code *et al.*³ that the pylorus and the terminal antrum discriminate between solids and liquids, holding back solids and retropelling them into the body of the stomach while liquids are allowed to pass, it seems inconceivable that gastric emptying of solids should be normal when the pylorus has been destroyed by pyloroplasty or bypassed by gastrojejunostomy. Indeed, it was subsequently shown by Dozois *et al.*⁹ that after the terminal antrum is excised, solid spheres empty more rapidly from the stomach of dogs.

Summary

Gastric emptying of a food-barium meal was measured radiographically in patients with duodenal ulcer without pyloric stenosis before operation, and in well-matched groups of patients who were in good health more than 1 year after highly selective vagotomy, truncal vagotomy and pyloroplasty and selective vagotomy and pyloroplasty. In each patient, the vagotomy was complete on insulin testing in the early postoperative period. The meal was palatable, and semi-solid in consistency. The patients were allowed to sit in a chair or to walk about in the intervals between X-rays.

The meal began to leave the stomach slightly earlier, but not significantly, in patients after truncal and selective vagotomy with pyloroplasty than in preoperative patients or patients after highly selective vagotomy.

The stomach was completely empty significantly sooner in patients who had undergone truncal and selective vagotomy with pyloroplasty than in duodenal ulcer patients or in patients after highly selective vagotomy.

The head of the meal reached the colon significantly sooner in patients after truncal and selective vagotomy with pyloroplasty than in preoperative duodenal ulcer patients. Thus, gastrointestinal transit was significantly

faster in patients who had undergone truncal or selective vagotomy with pyloroplasty than in patients with duodenal ulcer before operation. In patients after HSV, small-bowel transit was slightly faster than in duodenal ulcer patients, but was much less rapid than in patients after truncal or selective vagotomy with pyloroplasty.

These findings indicate that gastric emptying and small-bowel transit times are closer to normal in patients who have undergone HSV than in patients who have undergone truncal or selective vagotomy with pyloroplasty. On the other hand, there was no evidence of delayed gastric emptying after highly selective vagotomy.

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