

## PAPERS AND ORIGINALS

## Incidence of Dumping after Truncal and Selective Vagotomy with Pyloroplasty and Highly Selective Vagotomy without Drainage Procedure

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### Summary

The incidence of dumping after truncal or selective vagotomy with pyloroplasty and highly selective vagotomy without a drainage procedure was assessed both clinically and experimentally. At a gastric follow-up clinic dumping was found to be significantly less frequent in patients who had undergone highly selective vagotomy without a drainage procedure than in patients who had undergone truncal or selective vagotomy with pyloroplasty ( $P < 0.05$  or  $< 0.001$ , respectively). Hypertonic glucose given by mouth provoked the onset of dumping in 20% of patients with duodenal ulcer before operation, in 73% after truncal vagotomy and pyloroplasty, in 80% after selective vagotomy and pyloroplasty, and in 47% after highly selective vagotomy. The test meal also produced significantly greater decreases in blood pressure and increases in pulse rate in patients who had undergone vagotomy with pyloroplasty than in patients who had undergone highly selective vagotomy.

### Introduction

The precise cause of postcibal symptoms such as somnolence, faintness, sweating, and palpitations, which afflict so many patients after gastric surgery and which are collectively termed "early dumping," has been the subject of debate for many years. There is little doubt, however, that the basic defect is loss of "pyloric" control of gastric emptying, leading to the precipitate

entry of unsuitable material into the upper small intestine. The operation of highly selective vagotomy with preservation of an innervated antrum and without a drainage procedure (Amdrup and Jensen, 1970; Johnston and Wilkinson, 1970) was introduced in the hope that it would minimize side effects such as dumping and diarrhoea yet preserve protective and inhibitory mechanisms in the antrum and duodenum. In this paper we compare the incidence of dumping in patients treated by highly selective vagotomy with that in patients treated by conventional truncal or bilateral selective vagotomy with pyloroplasty on the same surgical unit.

### Patients and Methods

The 150 patients, 50 after each of the three types of vagotomy, are described in detail in the accompanying paper (page 788).

*Clinical.*—Symptoms of dumping were assessed "blind" at the gastric follow-up clinic one year after operation. Dumping was considered to be present when the patient volunteered or admitted to such symptoms as faintness, sweating, palpitations, or excessive somnolence shortly after a meal. Epigastric fullness alone was not considered to constitute dumping. Dumping was regarded as mild or moderate if the symptoms were so slight as to require little change in eating habits or could be avoided by such simple expedients as the omission of fluids and sugar with a meal. Symptoms necessitating a major reduction in the size of meals together with an alteration in their composition, which forced the patient to lie down after a meal, or which continued to cause great inconvenience despite care were classified as severe.

*Response to Oral Hypertonic Glucose.*—Inevitably any assessment of the severity of dumping at a gastric follow-up clinic is to some extent subjective. For this reason a test meal of hypertonic glucose, which is known to provoke dumping in susceptible individuals, was used to highlight and exaggerate any clinical differences in the liability to dumping which might exist among the different groups of subjects. Three groups of 15 patients who were representative of the three larger groups of postvagotomy patients, and 15 patients with uncomplicated duodenal ulcer before operation were chosen. Details of the provocative meal are given in the accompanying paper. In addition to recording

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any symptoms and objective signs such as pallor, sweating, and changes in conscious level varying from mild sleepiness to actual collapse, serial measurements of pulse rate and blood pressure were made throughout the test. Hence a much more objective assessment of the severity of dumping was achieved than was possible simply from listening to the patients at the clinic.

**Control Study.**—To avert the possible criticism that the searching interrogation at the clinic might lead to a falsely high impression of postvagotomy problems, 50 patients who had undergone relatively minor surgical procedures one year previously were included without the previous knowledge of the interviewing panel (see accompanying paper).

## Results

**Clinical Assessment.**—The incidence of early dumping found one year after the three operations is shown in Table I. Selective vagotomy and pyloroplasty led to the highest incidence of dumping, 34% of the patients being affected. It was only in this group

TABLE I—Clinical Incidence of Early Dumping One Year after Truncal or Selective Vagotomy and Pyloroplasty or Highly Selective Vagotomy Without Drainage Procedure

	Truncal Vagotomy and Pyloroplasty (50 Patients)	Selective Vagotomy and Pyloroplasty (50 Patients)	Highly Selective Vagotomy (50 Patients)	Controls (50 Patients)
Mild or moderate ..	20%	32%	6%	4%
Severe .. .. .	0	2%	0	0
Total .. .. .	20%	34%	6%	4

For statistical analysis see text.

of patients that symptoms of severe dumping were recorded. After truncal vagotomy and pyloroplasty the incidence of dumping was less (20%), and no severe cases were noted. However, the difference between truncal and selective vagotomy with pyloroplasty was not significant ( $\chi^2 = 2.43$ ,  $P > 0.1$ ). After highly selective vagotomy without a drainage procedure the incidence of dumping was 6%, significantly less than after truncal ( $\chi^2 = 4.33$ ,  $P < 0.05$ ) or selective vagotomy ( $\chi^2 = 12.25$ ,  $P < 0.001$ ). Of the control group who had undergone herniorrhaphy, appendicectomy, or operation for varicose veins 4% admitted to symptoms of mild dumping.

The hypertonic test meal produced dumping in 20% of patients before operation, in 73% after truncal vagotomy and pyloroplasty, in 80% after selective vagotomy and pyloroplasty, and in 47% after highly selective vagotomy (Table II). The difference

TABLE II—Number of Patients with Dumping after Test Meal of Hypertonic Glucose

	Duodenal Ulcer Before Operation (15 Patients)	Truncal Vagotomy and Pyloroplasty (15 Patients)	Selective Vagotomy and Pyloroplasty (15 Patients)	Highly Selective Vagotomy (15 Patients)
Mild or moderate ..	3	7	7	5
Severe .. .. .	0	4	5	2
Total .. .. .	3	11	12	7

For statistical analysis see text

between the "highly selective" group and the two other vagotomized groups taken together is statistically not quite significant ( $\chi^2 = 2.81$ ,  $P < 0.1$ ). However, the incidence of dumping in patients after both truncal vagotomy and pyloroplasty ( $P < 0.02$ ) and selective vagotomy and pyloroplasty ( $P < 0.01$ ) was significantly greater than in patients with duodenal ulcer before operation. The incidence of dumping in patients after highly selective vagotomy was not significantly greater ( $P > 0.1$ ) than in preoperative patients.

Ingestion of hypertonic glucose produced significantly greater hypertension ( $P < 0.05$ ) and significantly greater tachycardia ( $P < 0.05$ ) in patients after truncal and selective vagotomy with pyloroplasty combined than in those patients who had undergone highly selective vagotomy (Figs. 1 and 2, Table III).

TABLE III—Cardiovascular Changes after Ingestion of Hypertonic (25%) Glucose Solution. Results are given as Mean  $\pm$  1 S.E. of Mean of Greatest Change from Steady Pretest Value

	Duodenal Ulcer Before Operation (15 Patients)	Truncal Vagotomy and Pyloroplasty (15 Patients)	Selective Vagotomy and Pyloroplasty (15 Patients)	Highly Selective Vagotomy (15 Patients)
Increase in pulse rate (beats/min) ..	15.5 $\pm$ 2.10	29.3 $\pm$ 3.9	23.9 $\pm$ 3.3	17.9 $\pm$ 3.4
Decrease in systolic blood pressure (mm Hg)	5.3 $\pm$ 1.3	15.5 $\pm$ 2.3	12.8 $\pm$ 2.3	8.1 $\pm$ 2.1

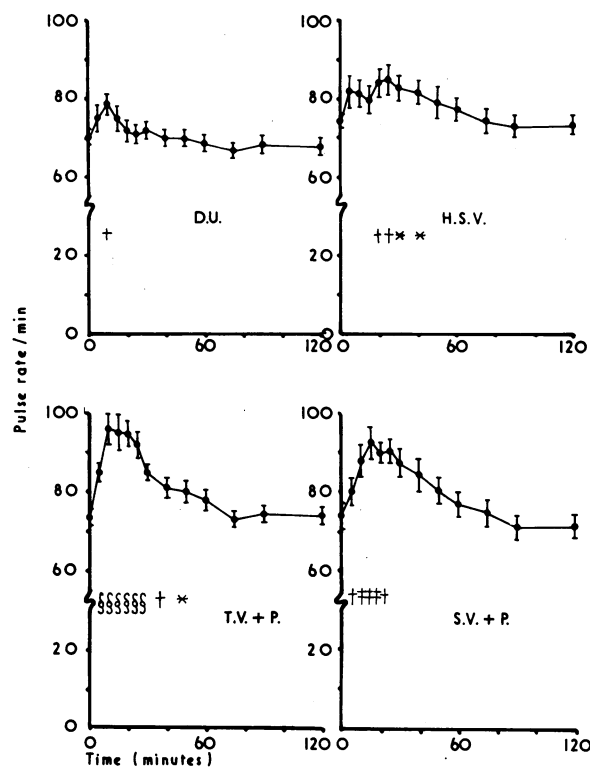


FIG. 1—Changes in pulse rate after ingestion of hypertonic glucose solution. Mean values  $\pm$  1 S.E. of Mean. Significance of difference from steady pretest values:

\*  $P < 0.05$ .  
 †  $P < 0.02$ .  
 ‡  $P < 0.01$ .  
 §  $P < 0.001$ .  
 D.U. = Duodenal ulcer before operation. H.S.V. = Highly selective vagotomy. T.V.+P. = Truncal vagotomy and pyloroplasty. S.V.+P. = Selective vagotomy and pyloroplasty.

## Discussion

A clinical study which compares the results of different forms of treatment is undoubtedly open to criticism when the patients had not been allocated at random to one or other of the treatment groups. As stated in the accompanying paper, however, we believe that the comparisons made here are probably valid, since the operations were all performed in the same surgical unit and the results were assessed in an unbiased manner by a panel who used the same criteria for assessment throughout.

Secondly, are the results reported here, consisting of information obtained only one year after operation, likely to be maintained on longer follow-up? This is particularly relevant since the incidence of dumping which we found one year after vagotomy and pyloroplasty was very high. This question can be

partially answered by comparing the results at one year reported here with the latest information we have on patients after truncal and selective vagotomy. A total of 158 patients were followed up for two years after truncal vagotomy and pyloroplasty in Leeds and York, and of these 9.7 reported symptoms of dumping (Goligher *et al.*, 1968). The five-year to eight-year results of this group show an incidence of early dumping of 11.9% (Goligher *et al.*, 1972). The incidence of dumping in 85 patients followed up for two to five years after selective vagotomy and pyloroplasty in Leeds was 22.4% (unpublished data from the Leeds gastric follow-up clinic). Thus after both these operations the well-known tendency for dumping to decrease with the passage of time can be discerned. This may be because many of the patients learn to avoid food which is particularly apt to provoke dumping. There seems no reason why the same process should

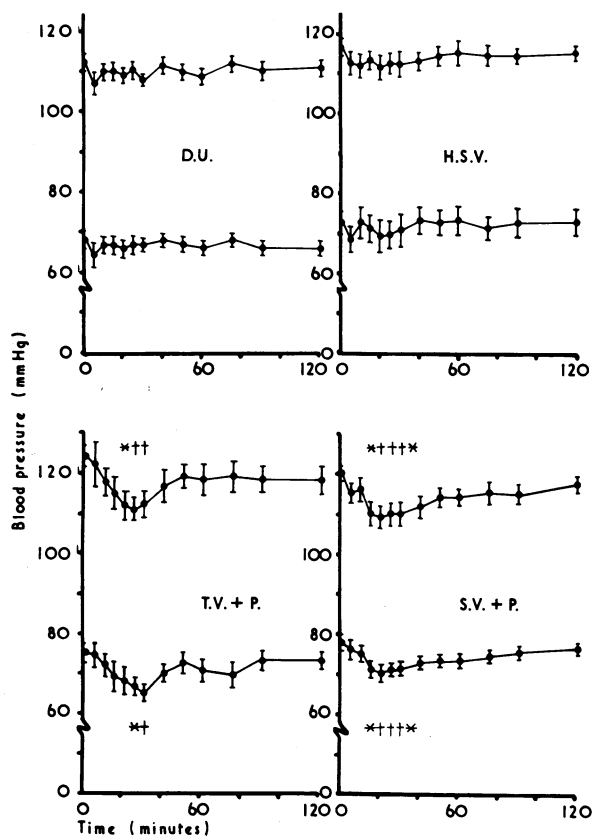


FIG. 2—Changes in blood pressure after ingestion of hypertonic glucose solution. Mean values  $\pm$  1 S.E. of mean. Significance of difference from steady pretest values:

\*  $P < 0.05$ .

†  $P < 0.02$ .

Abbreviations as for Fig. 1.

not apply to the incidence of dumping, small as it is, after highly selective vagotomy.

The incidence of dumping of all grades of severity after truncal and selective vagotomy with pyloroplasty is high but agrees with the figures quoted by other authors (Kraft *et al.*, 1967; Sawyers *et al.*, 1968; Dellipiani *et al.*, 1969; Kennedy and Connell, 1969; Tovey, 1969). Although this incidence may be expected to decrease with longer follow-up it is still likely to remain significantly greater than that found after highly selective vagotomy. Why dumping should occur more frequently after selective vagotomy than after truncal vagotomy is difficult to explain, although this observation is not new (Kraft *et al.*, 1967; Sawyers *et al.*, 1968; Kennedy and Connell, 1969; Tovey, 1969). It may be related to the fact that the vagal innervation of the small intestine is intact after selective vagotomy but absent after truncal vagotomy (Tovey, 1969). Thus dumping is more common in patients who have an incomplete vagotomy than in those

whose vagotomy is complete on insulin testing (Kennedy and Connell, 1969). Moreover, much evidence implicates the role of the release of vasoactive peptides and hormones from the small bowel (Silver *et al.*, 1966; Macdonald *et al.*, 1969; Buchanan, 1971). Does denervation of the small bowel impair the release of these substances? Certainly the histamine content of the upper small intestine is reduced after truncal vagotomy (Macdonald *et al.*, 1969), and probably some gut hormones are released less readily from a vagally-denervated intestine (Humphrey *et al.*, 1972a).

We have shown that the incidence of dumping is significantly lower after highly selective vagotomy without a drainage procedure than after vagotomy and pyloroplasty. Likewise, Amdrup in Copenhagen found significantly less dumping after highly selective vagotomy than after Polya partial gastrectomy for duodenal ulcer (Amdrup, 1971). This is scarcely surprising when one considers the importance of the antrum, pylorus, and duodenum for the regulation of gastric emptying (Thomas, 1957; Code, 1970; Dozois *et al.*, 1971) and thus for the prevention of dumping (Friesen and Rieger, 1960; Killen and Symbas, 1962; Goodale *et al.*, 1969; Amdrup *et al.*, 1970). It is perhaps more surprising that this operation should be followed by dumping at all. Nevertheless, gastric emptying is not quite normal after highly selective vagotomy: both fluid and semi-fluid meals leave the stomach more rapidly than in patients with duodenal ulcer before operation. These changes, however, are much less pronounced than those found when antropyloroduodenal regulation of gastric emptying is destroyed by total gastric vagotomy combined with pyloroplasty or gastrojejunostomy (Humphrey *et al.*, 1972b; Wilkinson and Johnston, 1972). Symptoms of dumping are not entirely confined to patients who have undergone vagotomy. Of 50 patients who had undergone herniorrhaphy, appendicectomy, or operation for varicose veins at least one year previously 4% admitted to symptoms of mild dumping when they were reviewed "blind" at the clinic.

Highly selective vagotomy reduces the secretion of acid and pepsin by the stomach as effectively as does truncal or selective vagotomy with a drainage procedure (Johnston and Wilkinson, 1970; Humphrey *et al.*, 1971). So far it has proved at least as effective as these operations in providing a cure for duodenal ulcer. At the same time preservation of the nerve supply to the antrum of the stomach eliminates the need for a drainage procedure except in patients who have advanced pyloric stenosis. The advantage of keeping interference with the normal anatomy and physiology of the gastrointestinal tract to a minimum is that healing of the ulcer need not be attended by side effects which have previously marred the results of gastric surgery.

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## Vagotomy Without Diarrhoea

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### Summary

The incidence of diarrhoea after three types of vagotomy was assessed "blind" at a gastric follow-up clinic one year after operation. Diarrhoea was recorded in 24% of patients after truncal vagotomy and pyloroplasty, in 18% after selective vagotomy and pyloroplasty, but in only 2% of patients after highly selective vagotomy without a drainage procedure. The incidence of diarrhoea was significantly less ( $P < 0.01$ ) after highly selective vagotomy than after either of the other procedures.

Hypertonic glucose solution given by mouth to 15 representative patients from each group and to 15 patients before operation provoked the onset of diarrhoea in 67% of the patients who had undergone truncal vagotomy and pyloroplasty, in 60% of those who had undergone selective vagotomy and pyloroplasty, in 13% of those who had undergone highly selective vagotomy without a drainage procedure, and in none of the pre-operative patients. Again the difference between the "highly selective" group and the other two groups of vagotomized patients was statistically significant.

It is suggested that postvagotomy diarrhoea is attributable both to unregulated gastric emptying after truncal or selective vagotomy with a drainage procedure and to the extragastric denervation produced by truncal vagotomy. "Postvagotomy" diarrhoea can be virtually eliminated by using highly selective vagotomy without a drainage procedure.

### Introduction

About 25% of patients experience episodic diarrhoea after truncal vagotomy with a drainage procedure for duodenal ulcer (Table I). The diarrhoea is usually quite mild, but in 2 or 3% it is so severe that in spite of relief from ulcer pain the patient believes that the operation has failed. The cause of the diarrhoea is not known and it can be very difficult to treat. The incidence of diarrhoea is significantly less after bilateral selective vagotomy (Kennedy and Connell, 1970) (Table I), in which the vagal nerve supply to the pancreas, biliary tract, and small intestine is preserved, but the incidence of around 12% is appreciable and a few patients still suffer severely. A different explanation

TABLE I—Comparison of Effects of Truncal and Selective Vagotomy\* on Incidence of Postvagotomy Diarrhoea

Source	Truncal Vagotomy		Selective Vagotomy	
	No. of Patients	% with Diarrhoea	No. of Patients	% with Diarrhoea
Burge <i>et al.</i> (1961) ..	100	26	100	12
Elliot-Smith <i>et al.</i> (1961) ..	131	2	44	2
Harkins <i>et al.</i> (1963) ..	60	68	52	29
Hedenstedt and Lundquist (1966) ..	30	50	44	6
Williams and Irvine (1966) ..	43	9	22	0
Kraft <i>et al.</i> (1967) ..	50	37	50	27
Mason <i>et al.</i> (1968) ..	42	33	40	20
Sawyers <i>et al.</i> (1968) ..	90	21	53	12
Hendry and Abdulla (1969) ..	300	23	100	9
Inberg (1969) ..	81	36	101	12
Tovey (1969) ..	118	7	100	9
Kronborg <i>et al.</i> (1970) ..	35	46	36	11
Kennedy and Connell (1970) ..	50	30	48	8
Total ..	1,130	24.6	790	12.3

\*With pyloroplasty, gastrojejunostomy, or antrectomy. In each series the same drainage procedure or resection was used.

for the diarrhoea is suggested by the finding that the stomach is incontinent of fluids after truncal or selective vagotomy with a drainage procedure (McKelvey *et al.*, 1969; McKelvey, 1970). Rapid gastric emptying is followed by swift passage of the liquid through the intestines, resulting in diarrhoea. Thus "postvagotomy" diarrhoea may be produced in some patients by vagal denervation of extragastric viscera, while in others destruction or bypass of the pylorus in combination with gastric vagotomy may be the principal factor.

If this hypothesis is correct the incidence of diarrhoea should be very low indeed after highly selective vagotomy, in which the vagal nerve supply to the extragastric viscera is preserved and the antropyloroduodenal segment is left completely intact (Amdrup and Jensen, 1970; Johnston and Wilkinson, 1970). We report here the results of an investigation into the bowel habits of three groups of patients one year after truncal vagotomy and pyloroplasty, selective vagotomy and pyloroplasty, and highly selective vagotomy without a drainage procedure.

### Patients and Methods

The 150 patients studied had undergone elective surgery for duodenal ulcer at least one year previously in the University Department of Surgery at Leeds General Infirmary. The operative procedures used were truncal vagotomy and pyloroplasty, bilateral selective vagotomy and pyloroplasty, and highly selective vagotomy without a drainage procedure (Fig. 1). Details of bowel habit were recorded when the patients attended the gastric follow-up clinic for review one year after operation. The patients were interviewed by a panel consisting of a physician, a radiologist, and two surgeons who were unaware of the type of gastric operation which had been performed. The last 50 consecutive patients treated by each type of vagotomy and seen one year after operation were chosen for review. Although the

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