concluded that suggested hypnotic anaesthesia effectively prevents the full rise in cortisol levels usually produced by pain—but may have no effect on the physiological response to cold in this respect.

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Bilateral Selective Vagotomy in Prevention of Post-vagotomy Diarrhoea

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Because of Dragstedt's work, vagotomy is fast spreading in all countries as the standard surgical treatment of duodenal ulceration. The operation as usually performed divides both vagus nerves as soon as they enter the abdomen. The anterior nerve trunks are divided above their hepatic branches—the liver, biliary system, pylorus, prepyloric stomach, and in part the duodenum are therefore all denervated, as well, probably, as some portion of the pancreas. The posterior nerve is divided above the coeliac division, and so the pancreas, the small and large gut, and other abdominal organs lose their vagal innervation.

This operation, which is still routinely performed in most centres, is now usually referred to as total abdominal vagotomy. Persistent episodic diarrhoea is a serious complication of it. In the episodic attacks liquid motions may be passed, with almost no warning, into the clothes. The recorded incidence of severe diarrhoea depends on the definition of severity used by the investigator. Like dumping after gastrectomy, both the incidence and the severity are closely related to the thoroughness of follow-up studies.

Many surgeons do not think that post-vagotomy diarrhoea is a common or serious problem. However, there seem to be no studies published to support such a view; on the contrary, when the subject has been studied with care the findings appear to be uniform, in spite of the difficult problem of defining and classifying this complication (Table I).

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The different types of selective vagotomy are shown in Fig. 1, while total abdominal vagotomy is shown in Fig. 2. Since 1958 we have used at the West London Hospital selective vagotomy in every case. The early results seemed to indicate that it was necessary to perform bilateral selective nerve section to obtain the best results (Burge, 1960). Further combined studies at the West London Hospital and the Glasgow Royal Infirmary confirmed the incidence and severity of diarrhoea after total abdominal vagotomy, but suggested that anterior selective nerve section was more important than posterior selective nerve section in the prevention of this complication. This conclusion has not been confirmed by the present study.

TABLE I

Authors	Incidence of Diarrhoea	
	Total	Severe
Pollock (1952) (V. and G-E.)	16%	7%
American Gastroenterological Association (1952) (V. and G-E.)	26%	—
Kraft et al. (1962) (V. and Pyl.)	38%	—
Smith and Farris (1963) (V. and Pyl.)	28%	—
Goligher et al. (1964) (V. and G-E.)	27%	6.5%
Cox and Bond (1964) (V. and G-E.)	23%	5%
Burge et al. (1964) (V. and Pyl.)	30%	8%

This study was planned to determine the importance of bilateral rather than anterior selective nerve section in the prevention of post-vagotomy diarrhoea. The series includes 321 cases—181 with anterior selective and 140 with bilateral selective nerve section.

FIG. 1.—Different types of selective vagotomy.

Material and Methods

In all cases selective vagotomy was combined with pyloroplasty. The 181 patients who underwent anterior selective vagotomy were operated on between 1961 and 1964, and the 140 bilateral selective cases between May 1964 and March 1966.

FIG. 2.—Total abdominal vagotomy.

All patients with post-vagotomy diarrhoea were seen and examined by us, and we have no doubt that the two series are strictly comparable.

Anterior Selective Vagotomy.—Only five of these 181 patients were untraced. Twelve (6.6%) had mild episodic diarrhoea and 18 (10%) had severe episodic diarrhoea—a total of 30 (16.6%) with diarrhoea of varying severity.

Bilateral Selective Vagotomy.—Of the 140 patients only one was untraced. Two (1.4%) had mild episodic diarrhoea, and in one case (0.7%) it was classified as severe, giving a total incidence of 2.1%. It is interesting, but presumably of no significance, that two of these three patients were operated on for hourglass deformity of the stomach secondary to benign lesser-curve gastric ulcer. The results are given in Table II,

TABLE II

	Episodic Diarrhoea		
	Mild	Severe	Total
Total abdominal vagotomy and pyloroplasty ..	17%	8%	25%
Anterior selective vagotomy and pyloroplasty ..	6.6%	10%	16.6%
Bilateral selective vagotomy and pyloroplasty ..	1.4%	0.7%	2.1%

TABLE III.—Details of Patients with Diarrhoea

Case No.	Sex	Age	Date of Operation	Pathology	Episodes of Diarrhoea	No. of Actions Daily	Duration of Diarrhoea (Days)	Urgency	Soiling	Distress	Classification
Anterior Selective Vagotomy (181)											
1	M	44	Aug. 1961	D.U.	Every 2 months	2	14	—	—	—	Mild
2	M	46	" 1961	D.U.	" 1 week	2-3	1-2	+	+	—	Severe
3	F	31	Feb. 1962	Pyloric ulcer and stenosis	" 1 month	3-4	1-2	+	+	+	"
4	F	63	" 1962	Duodenal stenosis	" 1 "	4-5	1-2	+	+	—	Mild
5	M	41	" 1962	D.U.	" 1-3 weeks	1	1	—	—	—	"
6	F	49	May 1962	D.U. and G.U.	" 2-4 "	2	1	+	+	+	Severe
7	M	63	June 1962	D.U.	" 1 month	1-2	1	+	+	+	Mild
8	M	36	" 1962	D.U.	" 1 week	3	2	+	+	+	Severe
9	M	45	July 1962	D.U.	" 1-2 weeks	2-3	1-2	+	+	+	"
10	F	34	" 1962	D.U.	" 1 month	1-3	1-2	+	—	+	"
11	M	41	Aug. 1962	D.U. and G.U.	" 1 week	3-4	1	+	+	+	"
12	F	56	" 1962	G.U.	" 1-2 weeks	1	1	—	—	—	Mild
13	M	51	Oct. 1962	Pyloric ulcer	" 1-2 "	3-4	1	+	+	+	Severe
14	F	41	" 1962	channel disease	Daily	3-4	Daily	+	+	+	"
15	M	49	Nov. 1962	D.U.	Every 1-2 weeks	1	1	+	+	+	"
16	F	55	Jan. 1963	G.U.	" 2-3 months	3-4	4-6	+	+	+	"
17	M	26	Mar. 1963	D.U.	" 1 month	1	1	+	+	—	Mild
18	M	62	" 1963	D.U.	" 2 months	1	1	+	+	—	Severe
19	F	23	June 1963	D.U. Pyloric stenosis	" 2 weeks	1-2	1	+	+	—	Mild
20	M	45	July 1963	D.U.	" 2-3 months	1-2	7	+	+	—	"
21	M	26	Aug. 1963	D.U.	" 3 months	1	2	+	+	—	Severe
22	M	56	Sept. 1963	Pyloric stenosis	" 1 week	2-3	2	+	+	—	Mild
23	F	47	" 1963	G.U.	" 2-3 months	1-2	1-2	+	—	+	Severe
24	F	62	Nov. 1963	H.H. Pyloric channel disease	" 2-3 weeks	5-6	1-2	+	—	+	Mild
25	M	41	" 1963	D.U.	" 1 month	1-2	1	—	—	—	"
26	M	39	Dec. 1963	Basal D.U.	Daily	3	Daily	+	—	—	"
27	M	48	Jan. 1964	D.U.	Every 3-4 days	3-4	1-6	+	+	+	Severe
28	F	63	Apr. 1964	Pyloric ulcer	" 4-5 months	3-6	1-6	—	—	—	Mild
29	M	64	May 1964	D.U. and H.H.	" 2-3 weeks	1	1-2	+	+	+	Severe
30	M	52	Feb. 1966	D.U.	Daily	2	Daily	+	—	+	Mild
Bilateral Selective Vagotomy (140)											
31	F	74	Aug. 1964	G.U. Pyloric stenosis. Hour-glass stomach	Every 2-3 days	2-3	Daily	+	+	+	Severe
32	F	52	" 1964	G.U. Pyloric stenosis. Hour-glass stomach	" 1 month	2	1	—	—	—	Mild
33	M	56	Dec. 1965	D.U.	" 3-4 days	1	1	—	—	—	"

and are compared with an average figure for total abdominal vagotomy and pyloroplasty found at the West London Hospital and by other workers.

Table III shows details of each patient with diarrhoea. The classification of severity was dependent on the degree of distress and/or soiling of the clothes.

Discussion

The operation of total abdominal vagotomy has been studied at the West London Hospital since 1950. The first investigation was a nation-wide study carried out by Pollock (1952). These same patients were studied again by Lloyd Davies (1956), by Burge and Pick (1958), and again by Burge and Clark (1960). In each of these investigations the incidence of post-vagotomy diarrhoea was the same. Persistent episodic diarrhoea occurred in some 30% of cases, and the incidence of severe diarrhoea was disturbing.

At one time some surgeons thought that this diarrhoea might be caused not by the vagotomy but by the drainage operation used in association with it. This view can be discounted. A patient with a gastrojejunal ulcer after gastrectomy may have normal bowel actions, yet when nothing more than vagotomy is added persistent and severe diarrhoea may follow.

Nevertheless, persistent diarrhoea may—though rarely—follow a gastric drainage operation. It occurs sometimes after Polya gastrectomy when both the hepatic plexus and the coeliac division of the posterior nerve are intact. Rarely it may follow simple gastroenterostomy (Burge *et al.*, 1961); probably it occurs, though even less often, after pyloroplasty.

One of our patients, because of a badly made pyloroplasty, developed gastric retention and a lesser-curve gastric ulcer after a vagotomy and pyloroplasty performed for chronic duodenal ulceration. There was no diarrhoea after this operation, yet when a gastrojejunostomy was added to overcome the gastric retention and to cure the lesser-curve gastric ulcer she developed persistent episodic diarrhoea.

Long-term follow-up studies of total abdominal vagotomy and pyloroplasty and of total abdominal vagotomy and gastrojejunostomy showed the incidence and severity of diarrhoea to be the same (Burge *et al.*, 1964).

Observations of Other Workers

It is interesting now to review the findings of other workers who have studied the value of selective vagotomy in the prevention of post-vagotomy diarrhoea and to speculate on the discrepancy between their findings and our own.

Kraft *et al.* (1962) found post-vagotomy diarrhoea in 38% of their patients with total abdominal nerve section and simple drainage. They reported that the incidence fell to 19% after bilateral selective section and drainage in a later series. Smith

FIG. 3.—Transverse section of hepatic plexus.

and Farris (1963) found an incidence of alteration in bowel habit in 28% of patients with total abdominal vagotomy. This figure was reduced to 12% in a comparable series with selective vagotomy. Harkins *et al.* (1963) reported an incidence of 68% of post-vagotomy diarrhoea after total abdominal nerve section together with antrectomy. The incidence of diarrhoea was reduced to 29% in another series with bilateral selective vagotomy and antrectomy. Each of these three groups of workers described the anatomy of the abdominal vagus with reference to the selective operation. Each of them seems to have described a single hepatic nerve trunk passing from the anterior vagus to the portal fissure. In their description of the technique of the operation they seemed to show how this single hepatic nerve is dissected free and preserved.

We have always had an entirely different concept of the vagal innervation of the liver, biliary system, and pyloroduodenal region. We have shown (Burge, 1964)—as in fact Swan (1830) knew—that there is not a single hepatic branch but a very considerable hepatic plexus, which we preserve entirely. Fig. 3 shows a section taken across the plexus. Many fine nerve fascicles are present.

It would seem to us that if a single hepatic nerve is carefully dissected free the plexus must be in large part destroyed. This different approach does, we believe, account for the discrepancies between the findings of other workers and our own; we believe the difference is one of technique. Grassi (1967) stressed the importance of selective vagotomy in the prevention of post-vagotomy diarrhoea.

The selective operation has been used in man in its different forms routinely since 1958 at the West London Hospital. We believe it more reasonable to think that post-vagotomy diarrhoea is caused by denervation of organs other than the stomach rather than by denervation of the stomach itself. Because no functional disturbance of these extragastric organs can be found after total abdominal vagotomy, it must not be concluded that when denervated they are not to blame for this complication. The known physiology of these organs is probably only a minute part of the whole. Our studies are empirical.

There is little doubt that every surgeon, in performing anterior selective vagotomy, must sometimes fail to preserve the hepatic plexus completely. It would not be surprising, therefore, if occasional error in technique was responsible for a small incidence of diarrhoea in any one series.

Summary

The incidence of diarrhoea was found to be 16.6% after anterior selective vagotomy and 2.1% after bilateral selective vagotomy. Other surveys have shown a much higher incidence after total vagotomy. We believe that post-vagotomy diarrhoea is a common and serious complication of total abdominal vagotomy and that it is prevented by bilateral selective nerve section. Diarrhoea after total vagotomy is probably caused by denervation of organs other than the stomach.

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