The effect of vagotomy and drainage on the small bowel flora

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SUMMARY   The incidence of small intestinal colonization in unoperated duodenal ulcer patients was low and similar to that in the normal population. The majority of patients seven to 10 days following truncal vagotomy and drainage were colonized whereas none of a control group of patients following simple closure of a perforated duodenal ulcer was colonized. In patients with pyloroplasty, this high incidence fell to control levels on average 18 months postoperatively, but in patients with a gastro-jejunostomy, the incidence remained raised probably due to the presence of the afferent loop.

Only two patients developed episodic diarrhoea and there was no obvious association with small bowel colonization.

Diarrhoea is a well recognized complication of vagotomy and drainage (Cox and Bond, 1964). There is much debate about the incidence and severeity of this symptom and in those patients in whom diarrhoea does occur the aetiology is obscure, although bacterial colonization of the upper small intestine has been suggested as a factor (Dragstedt and Woodward, 1951). Bacterial colonization is generally thought to be influenced both by gastric acid secretion and intestinal motility (Donaldson, 1964), both of which are known to alter following vagotomy and drainage (Gillespie, Clark, Kay, and Tankel, 1960; George, Connell, and Kennedy, 1968).

This study had two objectives: first to assess the incidence of small intestinal colonization in duodenal ulcer patients, and secondly to assess the effect of vagotomy and drainage on the small bowel flora and bowel habit at intervals following surgery.

Methods

The incidence of bacterial colonization of the upper small intestine was studied in 35 patients (29 male, six female, mean age 44·5 years) with chronic duodenal ulcer (group A). Samples of small bowel content were aspirated for bacteriological culture using an orally passed polyethylene tube, guided into the upper small intestine under radiological control.

A further group of 25 patients (group B) (23 male, three female, mean age 48 years) who had had elec-

tive surgery for chronic duodenal ulcer was studied. Each patient had bilateral truncal vagotomy: in 11 patients this was combined with a Heineke-Mikulicz pyloroplasty and in 14 with a retrocolic gastro-jejunostomy. Samples of small bowel content were aspirated for bacteriological study seven to 10 days postoperatively, and again between six months and two years (mean 18 months) after operation. In 17 of these 25 patients the samples in the early post-operative period were obtained by aspiration through the feeding limb of a Kay's gastrostomy catheter (Kay, 1964), this limb having been placed in the upper small bowel at the time of operation. In the remaining eight patients, and in all 25 patients on follow up, samples were obtained as in group A patients.

In addition to the bacteriological studies these patients had the following investigations: (1) The maximal acid response to pentagastrin, 6 micrograms per kilogram body weight, was measured preoperatively and seven to 10 days postoperatively. (2) An insulin test was performed seven to 10 days postoperatively and interpreted according to Hollander's criteria (Hollander, 1948). (3) The bowel habit was recorded before operation, immediately after operation and regularly on follow up.

A third group of eight patients (group C) (all male, mean age 39 years) admitted as emergencies with perforated duodenal ulcer was also studied. Each patient had a simple closure of the perforation but no vagotomy or drainage procedure was performed. Samples of upper small bowel content were aspirated for culture in the first seven to 10 days

after operation by the method used for group A patients.

The small intestinal samples were taken on average one hour postprandially and no patient was receiving antibiotics at the time.

BACTERIOLOGICAL CULTURE

The samples of intestinal content were cultured within one hour of aspiration. A tenfold dilution of the aspirate was made in distilled water reducing the viscosity of the fluid to enable more accurate plating. An estimate of the viable colony count was obtained using a standard plating technique (Urquhart and Gould, 1965) with at least four days' incubation under aerobic and strict anaerobic conditions. The latter conditions were achieved by vacuum extraction and hydrogen flushing of a BTL (Baird and Tatlock, Limited, Chadwell Heath, Essex, Great Britain) modification of a McIntosh-Fildes anaerobic jar. The media employed were Brain heart infusion blood agar (Oxoid), Mac-Conkey no. 2 agar (Oxoid), mannitol salt agar (Oxoid), boiled blood nutrient agar (Cruickshank, 1968), Sabouraud's 4% glucose agar (Cruickshank, 1968), and phenyl ethyl alcohol tomato juice boiled blood agar (Buchan and Gould, 1967). Identification of the isolates was confirmed according to Bergey's *Manual of Determinative Bacteriology* (1957).

The aspirates were classified into four groups as follows:

Group I
'Sterile', ie, $< 10^4$ organisms/ml aspirate.

Group II
Upper respiratory tract flora in concentrations of $\geqslant 10^4$/ml aspirate. This included the aerobic genera Staphylococcus, Streptococcus, Corynebacterium, Haemophilus, Neisseria, Lactobacillus, and Nocardia, and also yeasts and fungi.

Group III
'Coliform colonization', ie, members of the Enterobacteriaceae in concentrations of $\geqslant 10^5$/ml aspirate.

Group IV
'Anaerobic colonization', ie, as for group III with the addition of the anaerobic genera Veilonella, Bacteroides, Lactobacillus, and Clostridium.

Aspirates classified as group III or IV (faecal type organisms) were considered to be indicative of significant colonization of the upper small bowel. Significant colonization was therefore defined as 'the presence in the upper jejunum of faecal type organisms in a concentration of at least 10^5/ml aspirate'. In the subsequent text the term 'colonization' is used to denote 'significant colonization'.

Results

INCIDENCE OF COLONIZATION

The incidence of colonization of the upper small intestine in unoperated duodenal ulcer patients was 3% (one of 35 patients). In the first seven to 10 days following vagotomy and drainage, 92% (24 of 25 patients) were colonized. This incidence is significantly higher than in the unoperated group ($p < 0.0001$). All statistical analyses used Fisher's exact method (Fisher and Yates, 1963). At this time none of the eight patients with a simple closure of a perforated duodenal ulcer was colonized; the difference between these patients and the 25 patients with vagotomy and drainage is statistically significant ($p < 0.0001$).

When the 25 patients were studied on average 18 months postoperatively 32% (eight of 25 patients) were still colonized. This incidence is significantly lower ($p < 0.0001$) than that seen in the immediate postoperative period, but still higher ($p < 0.0001$) than the control group of unoperated duodenal ulcer patients.

DRAINAGE PROCEDURE

Table I shows the incidence of colonization according to the type of drainage procedure. There was no significant difference between pyloroplasty and gastrojejunostomy immediately after operation. On follow up, however, the incidence of colonization following pyloroplasty fell from 100% to 9%, this fall being statistically significant ($p < 0.0001$). Following gastrojejunostomy there was a similar but less marked fall from 86% immediately after operation to 50% on follow up; this fall is also statistically significant ($p < 0.05$). The difference in incidence at follow up between pyloroplasty and gastrojejunostomy is statistically significant ($p < 0.05$).

Time after Operation	Gastrojejunostomy		Pyloroplasty	
	No. Studied	No. Colonized	No. Studied	No. Colonized
7-10 days	14	12 (86%)	11	11 (100%)
18 months	14	7 (50%)	11	1 (9%)

Table I   *Incidence of colonization of group B patients in relation to drainage procedure*

Group		No. Studied	No Diarrhoea		Diarrhoea	
			Colonized	Not Colonized	Colonized	Not Colonized
A	Unoperated	35	1	33	0	1
B	7-10 days postoperative	25	19	1	5	0
	18 months postoperative	25	8	15	1	1
C	7-10 days postoperative	8	0	7	0	1

Table II   *The presence or absence of diarrhoea compared with the state of colonization*

ACID SECRETION

The maximal acid output, expressed as the mean ± 1 standard error in m equiv per peak half hour, at seven to 10 days after operation was 4·9 ± 1·0 in the patients who were colonized compared with 7·3 ± 5·1 in those who were not colonized. In these same patients, on average 18 months later, it was 4·1 ± 1·5 in those who remained colonized and 5·5 ± 1·3 in those who were not colonized. There was no statistically significant difference between any of these figures.

INSULIN RESPONSE

Only two of the 25 patients were judged, using Hollander's criteria, to have had an incomplete vagotomy. One patient had an early positive and the other a late positive response. The former was colonized in the immediate postoperative period but had ceased to be colonized at the time of follow up. The latter was not colonized either in the immediate postoperative period or on the follow up studies.

BOWEL HABIT

Comparing the bowel habit of the 25 patients 18 months after operation with the preoperative habit, three had a more frequent motion and of these none was colonized; two had a less frequent motion and of these one was colonized, and 20 had no change and of these seven were colonized.

DIARRHOEA

Diarrhoea was defined as 'the continuous or episodic occurrence of loose bowel movements passed with a degree of urgency'. Table II shows the incidence of diarrhoea in the three groups together with the incidence of colonization. In the first seven to 10 days following vagotomy and drainage, five of the 25 patients (20%) had an attack of diarrhoea. Although each of these five patients was colonized, 19 of the 20 patients without diarrhoea were also colonized. At follow up two patients complained of diarrhoea; one had diarrhoea preoperatively but following surgery the diarrhoea was of a greater severity, required medication, and the small intestine was not colonized. The other patient had no diarrhoea and the small intestine was colonized with anaerobic

organisms. At no stage was one specific organism isolated nor was anaerobic colonization commoner.

Discussion

The main findings of this paper are that following vagotomy and drainage there is a very high incidence of colonization of the upper small intestine in the first 10 days after operation and that this high incidence of colonization falls with the passage of time; the fall is more pronounced in patients who have pyloroplasty than in patients with gastrojejunostomy as the drainage procedure.

Duodenal ulcer patients have an incidence of colonization similar to that reported in patients without evidence of gastrointestinal disease (Cregan and Hayward, 1953; Kalser, Cohen, Arteaga, Yawn, Mayoral, Hoffert, and Frazier, 1966; Drasar, Shiner, and McLeod, 1969; Mallory, Savage, Kerr, and Smith, 1973). The high incidence in the early postoperative period is unlikely to be due to a non-specific effect of operation as patients undergoing repair of a perforated duodenal ulcer did not show a comparable incidence. The higher incidence cannot be explained by the use of a Kay's gastrostomy tube as all of the eight patients sampled via an orally passed tube were colonized. Perhaps the most likely factor is a transient impairment in gastric emptying and small bowel motility known to occur immediately following vagotomy (Ross, Watson, and Kay, 1963; Earlam, 1972).

Greenlee, Vivit, Paez, and Dietz (1971), who studied patients before and two months after vagotomy and antrectomy, found a similar high incidence of colonization after operation. They, however, found that in patients with a gastroduodenal anastomosis the high incidence was maintained one year later, whereas we found that the incidence fell markedly in patients with a pyloroplasty. They, however, studied patients who had an antrectomy whereas our patients all had an intact antrum. Why should the fall be so marked in pyloroplasty patients? There was no obvious difference between the pyloroplasty and gastrojejunostomy patients other than the presence of a potential blind loop in the latter. It may well be that this is the important reason for the higher

incidence of colonization in that group. Why should some and not all patients with a gastrojejunostomy remain colonized? It has been suggested that the length of the afferent loop influences the incidence of colonization (Wirts and Goldstein, 1963). The length of the afferent loop in those who were colonized was 6·5 ± 0·8 cm against 6·4 ± 2·0 cm in those who were not colonized (mean ± 1 standard error). The length does not indicate the degree of stasis and it could be that patients not colonized still emptied part of the gastric contents through the pylorus.

The role of gastric acid secretion in the prevention of colonization of the upper small intestine is debated (Cregan, Dunlop, and Hayward, 1953; Dellipiani and Girwood, 1964; Gray and Shiner, 1967; Greenlee et al, 1971). We (Browning, Mackay, and Buchan, 1969), in a larger group of patients studied immediately after vagotomy and drainage, found that those who were colonized had a lower mean maximal acid output. In this study, however, we have been unable to demonstrate any correlation between the level of acid secretion and the presence or absence of colonization of the small bowel.

Although this study was not primarily concerned with the investigation of diarrhoea, in the small number of patients who did complain of this symptom, there was no obvious correlation with their small bowel flora. Though Tinker, Hoffbrand, Mitchison, Tabaqchali, and Cox (1971), also in small numbers, found no correlation, bacterial colonization of the upper small bowel is often associated with steatorrhoea (Tabaqchali, 1970). As this is a common occurrence after gastric surgery (Cox, Bond, Podmore, and Rose, 1964) an interrelationship could be postulated. Alternatively, certain bacteria are capable of bile salt deconjugation (Midtvedt and Norman, 1967) and either by depleting the total micellar concentration (Northfield, 1973) or by direct action of free bile acids on the small intestinal mucosa (Gracey, 1971) or on the colon (Soong, Thompson, Paley, and Hess, 1972) diarrhoea could occur. We hope in the future to publish data on a larger number of patients with diarrhoea.

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