Bio-Physics Laboratory, and by Professor John McMichael and Dr. C. M. Fletcher, of the Department of Medicine of the Postgraduate Medical School. Dr. J. West, of the Medical Research Council's staff, has made valuable contributions in the initial use of the instrument. Mr. C. Lawden and Mr. T. Neal were responsible for construction of the instrument in the Postgraduate Medical School workshop.

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COMPARISON OF SIDE-EFFECTS AFTER PARTIAL GASTRECTOMY AND VAGO- TOMY AND GASTRO-ENTEROSTOMY*

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Partial gastrectomy is a well-established procedure with a low mortality rate and a low incidence of anastomotic ulcers. Dissatisfaction with it correctly centres in its side-effects—that is, those symptoms not due to ulceration. The figures for mortality rates and anastomotic ulcers are easily definable, but the side-effects prove a difficult field to chart. Numerous surgical procedures have been devised with the object of reducing or eliminating them: fixing the gastric stump, changing the position of the stoma, the combination of vagotomy with practically every known variant of partial gastrectomy, and, more recently, Billroth I for duodenal ulcer. If gastric operations, in an attempt to reduce side-effects, are not to show a discouraging tendency to rotate in popularity, the results of different procedures must be compared with a fixed standard.

This fixed standard should be a simple clinical yardstick which illustrates principles rather than catalogues symptoms and which omits comparative terms as a basis or aid to comparison.

This paper compares the side-effects in 100 patients who have had partial gastrectomy for duodenal or anastomotic ulcer with the side-effects in 100 cases of duodenal ulcer treated by vagotomy and posterior

gastro-enterostomy. Each type of operation was carried out in comparable and unselected cases.

No case included in this report has been operated on during the past 12 months. As long-term results of vagotomy and posterior gastro-enterostomy are still unknown, it was decided to limit to 100 the number of cases in which this operation was carried out as a routine.

Facts have been collected in respect of the following points: (1) biliary regurgitation; (2) ability to take a normal-size mixed meal; (3) ability to take a one- or two-course meal; (4) the presence of selective impairment of digestion; (5) the incidence of dumping; and (6) the existence of any interrelation between the above.

All 200 patients have been personally interviewed on more than one occasion. The above questions were evolved with the object of demonstrating underlying principles.

PARTIAL GASTRECTOMY FOR DUODENAL ULCER

This operation was carried out for duodenal ulcer in 83 cases and for anastomotic ulcer in 17 cases (after posterior gastro-enterostomy 16, after pyloroplasty 1). Gastric section in all cases was carried out after division of the left gastric artery at the point at which it gives off the descending branch and after division of the lower two vasa brevia. Reconstruction was as follows: antecolic with spur, 85 cases; Polya, 8; Moynihan 1; Schoemaker 5; and Finsterer, 1. The afferent loop was made as short as possible consistent with the avoidance of tension.

Follow-up—Ninety-eight cases were operated on between 1947 and 1953, inclusive, and two in 1954. The average time between the date of operation and the date of this follow-up was four years five months. Eleven patients did not attend for review; the next 11 were therefore reviewed.

Biliary Regurgitation

Investigation into the incidence of biliary regurgitation in 100 patients gave the following results:

Nil	..	..	..	..	..	74 patients
Definite	..	..	..	..	..	5
(1) $\frac{1}{2}$ pint (285 ml.)	once a day	..	..	..	..	1 patient
(2) $\frac{1}{2}$ " (285 ")	" " week	..	..	..	..	1 "
(3) $\frac{1}{2}$ " (285 ")	" " in two months	..	..	..	..	1 "
(4) Half a cupful (85 ml.)	three times a week	..	..	..	..	1 "
(5) " (85 ")	once a month	..	..	..	..	1 "
Negligible (less than a mouthful once a week)	..	..	..	..	..	21 patients

Regurgitation of bile was therefore nil or negligible in 95 patients. Of the five patients with definite biliary regurgitation four had an antecolic partial gastrectomy with a spur and one had a Polya gastrectomy; four were females and one was a male.

Ability to take a Normal-size Mixed Meal

By this is meant the ability to take the normal-size two-course meal, whether in the evening or midday, composed of meat or fish and potatoes as the first course, and milk puddings, steamed puddings, etc., as the second course. The patient was asked to compare the size of the meal with the size of the corresponding meal prior to the development of the ulcer. No account has been taken of any patient's inability to take a large meal.

Group A: 55 patients were able to take a normal-size mixed meal.

Group B: 45 patients were unable to take a normal-size mixed meal.

In just under 50% of patients, therefore, there is a quantitative reduction in the food taken in this meal. An inability to take a normal-size meal may be a major handicap. The underlying problem has, we believe, not been pursued to its logical conclusion. A patient who is unable

*Based on a paper read before the Section of Surgery of the Manchester Medical Society on March 13, 1956.

to take a normal-size meal may be found to be omitting either course or to be taking a reduced amount of each course.

Ability to take a One- or Two-course Meal

The patient was asked whether he was taking a one- or two-course meal, and if the former, which course he now omitted. The patient was also asked to compare this with his ability to take a two-course meal before the development of the ulcer. Of the 100 patients under consideration, 35 were found to have been deprived by partial gastrectomy of their ability to take a sweet course. The distribution of these 35 patients in the two groups is as follows:

Group A: of the 55 patients able to take a normal-size meal, only 6 did not take a sweet course.

Group B: of the 45 patients unable to take a normal-size meal, 29 did not take a sweet course.

No patient had been deprived of his ability to take a meat or fish course.

The actual figures obtained were:

Sweet Course			
Group A		Group B	
Yes	46	Yes	13
No	6	No	29
No (and no pre-ulcer)	3	Occasionally (daily pre-ulcer)	3

It will be seen that 46 patients were taking a normal-size meal with a sweet course and 29 were not taking a normal-size meal or a sweet course.

Selective Impairment of Digestion

Patients were asked to compare their ability to take milk, as such, milk puddings, eggs, fatty foods, chocolates, and pastries at the time of the follow-up, with their ability to take the same foods prior to the development of the ulcer. These foods—fatty, sweet, and sweet fatty—were chosen as representing the constituents of the second or sweet course; any patients being deprived of the ability to take these foods would also be deprived of the ability to take a sweet course in virtue of what may be termed—for want of a particular phraseology—a selective impairment of digestion.

Group A

Selective Impairment of Digestion in 46 Patients Having a Normal-size Meal with a Sweet Course

Ability to Take	Yes	No	No/No	Uncertain
Milk	25	9	5	1
" puddings .. .	41	3	—	2
Fatty foods .. .	40	1	3	2
Eggs	42	1	2	1
Chocolates .. .	31	7	6	2
Pastries .. .	31	8	5	2

Six patients in addition stated that they could take milk but that they did not require it.

The word "No" in the tables indicates that the patient has been deprived of the ability to take the food in question because of the production of clearly defined symptoms after ingestion: nausea, palpitation, weakness, vertigo, sweating, marked flatulence, or a feeling of marked distension. Occasionally a definite dislike only has led to the omission of these particular foods.

"No/No" indicates that the patient did not take the particular food prior to the ulcer or after gastrectomy. Under the heading "Uncertain" are placed those few patients who gave uncertain or conflicting answers or who were not asked the question under consideration.

Of the 46 patients in this group having a normal-size meal and a sweet course, 25 were taking all of the following: milk, milk puddings, fatty foods, and eggs. (These include three patients who usually did not drink milk because they felt they did not need it but who could do so if they wished.) Not one patient out of the 46 had been deprived by partial gastrectomy of his ability to take all of the following: milk, milk puddings, fatty foods, and eggs.

Group B

Selective Impairment of Digestion in 29 Patients Not Having a Normal-size Meal or a Sweet Course

Ability to Take	Yes	No	No/No	Uncertain
Milk	9	16	2	—
" puddings .. .	6	22	—	3
Fatty foods .. .	8	16	2	3
Eggs	12	15	—	2
Chocolates .. .	6	16	3	4
Pastries .. .	8	16	1	4

Two patients in addition stated that they could take milk but they felt they did not require it. Similarly one patient could take milk puddings if he wished.

One patient included in the nine taking milk was taking cold but not hot milk. The statistics relating to the ability to take cold but not hot milk may be fallacious owing to the small number of patients taking hot milk by itself.

The diagram compares the selective impairment of digestion in those patients who can and those who cannot take a sweet course.

Comparison of the average ability to digest milk, milk puddings, fatty foods, and eggs in those patients who can and those who cannot take a sweet course.

Of the 29 patients not taking a normal-size meal or a sweet course, only two were taking milk, milk puddings, fatty foods, and eggs. Five patients in this group had been deprived by partial gastrectomy of their ability to take all of the following: milk, milk puddings, fatty foods, and eggs; in addition 10 had been deprived of their ability to take three of these four foods.

There is an impressive difference in selective impairment of digestion between those patients who can and those who cannot take a sweet course. This indicates clearly that the main reason why the patient cannot take a sweet course is a failure of digestion for the sweet fatty foods which constitute this course. The attempt to digest these foods produces unpleasant symptoms, and they are therefore omitted from the diet. The facts set out in these tables cannot be accounted for solely by a reduction of reservoir or holding capacity. For example, a reduction of this holding capacity sufficient to allow a patient to take meat and potatoes but not a sweet course would be quite inadequate to account for the inability of the same patient to take the same quantity of fatty foods and eggs or to drink milk with the stomach empty, especially when he can drink the same quantity of water, tea, or beer.

There is much confusion between sweet and sweet fatty foods, the fat element usually being overlooked. One patient stated that she never took anything sweet. This on further questioning was found to mean that she never ate chocolates but was very fond of barley sugar or sugar in tea. Six patients had been deprived by partial gastrectomy of their ability to take fatty foods, chocolates, and pastries and yet were taking substantial amounts of sugar in tea. This suggests that it is the fat in reputedly sweet things—that is, chocolates and pastries—either by itself or in combination with the sweet element which determines the inability to digest.

This selective impairment of digestion has occurred after the following types of partial gastrectomy—antecolic with spur, Polya, Schoemaker, and Moynihan.

It should be emphasized that the average time of follow-up after partial gastrectomy was four years and five months.

Varying accounts have been given of the incidence of pulmonary tuberculosis after partial gastrectomy. The correct answer is surely the most obvious. The main difference in any patient after partial gastrectomy and, for example, cholecystectomy, or in the same patient before and after partial gastrectomy, is the severe quantitative and qualitative reduction in food intake that may follow this latter operation. This must at times be responsible for lighting up a latent tuberculous focus. One patient who had been deprived by partial gastrectomy of the ability to take milk, milk puddings, fatty foods, chocolates, and pastries for five years developed pulmonary tuberculosis with a cavity and a positive sputum.

Incidence of Dumping

By dumping is meant attacks consisting of most or all of the following symptoms: vertigo, weakness, palpitation, and sweating. The total number of patients dumping was 19. This bald statement, however, conveys nothing of the underlying physiological defect or of the handicap imposed. It is essential, where possible, to establish what precipitates the attacks.

In six patients the attacks bore no ascertainable relation to any particular food; in two of these the dumping attacks came on after a large meal irrespective of the type of food consumed. In two patients the attacks were not related to meals at all. In one patient moderate attacks of dumping occurred on entering a warm room. In one patient there was no dumping for two years; attacks of dumping then came on, and were worse after exercise. In four patients, therefore, the attacks bore no relation to meals or any particular food.

The largest number of patients dumping—13 in number—all fall into one well-defined group. In every patient in this group the dumping attack was directly induced by one or more of the following: milk, milk puddings, fatty foods, eggs, chocolates, and pastries. In three of these patients dumping was, in addition, produced by a large meal. The relation of dumping to a large meal, however, was not specifically asked for in each case. If a patient has discovered that attacks of dumping are directly induced by certain foods it is reasonable to suppose that these foods would be omitted from the diet. An inquiry into the diet of these 13 patients reveals the following:

	No	Yes
Normal-size meal	11	2
Sweet course	12	1

The selective impairment of digestion in these 13 patients was as follows:

	No	Yes	Doubtful
Milk	10	3	—
Milk puddings	12	1	—
Eggs	8	4	1
Fatty foods	11	2	—
Chocolates and pastries ..	12	1	—

The conclusion to be drawn from these tables is clear—in order to avoid attacks of dumping the patient has omitted from his diet those foods that produce them. In other words, the main handicap of dumping in these patients is the handicap imposed by avoiding it. It should be again emphasized that these findings do not relate to the early post-operative period in which dumping may more often follow a large meal and in which the patient has not had time to sort out those foods particularly associated with dumping.

On further questioning, all these 13 patients have stated that, with particular care in avoiding the foods that produce dumping, the attacks of dumping have been eliminated. The number of patients, therefore, who were actually experiencing unavoidable dumping attacks was four—that

is, those patients already referred to whose attacks bore no relation to meals or any particular food.

In order to confirm statements that attacks of dumping followed ingestion of certain foods, patients have been brought to the out-patient department and given a glass of hot milk containing two eggs. It had previously been ascertained from the patients that attacks followed these foods. Attacks of dumping have followed and have been directly observed. The production of dumping by a glass of milk with two eggs, the fatty meal of the cholecystogram test, with its known hormonal action, may eventually put the dumping syndrome on a firm physiological basis. It will also be recalled that systemic disturbances in a case of argentaffinoma have been provoked by fatty foods (Bleehen, 1955).

A loss of reservoir or holding capacity and an inability to take sweet foods does undoubtedly occur after partial gastrectomy; an inability to take purely sweet foods is no material handicap or hardship to anyone; a loss of holding capacity is undoubtedly responsible for a definite reduction in food intake, but has previously been allowed to overshadow in importance the effect of selective impairment. An inability to take milk, milk puddings, fatty foods, and eggs is a determining factor in the production of the post-gastrectomy defects—inability to take a normal-size meal, inability to take a sweet course, and attacks of dumping. The cause must be physiological; it is therefore difficult to understand how this digestive disability can be reduced or eliminated by such advocated procedures as fixing the gastric stump or changing the position of the stoma from the lower third to the middle third in Billroth II modifications.

It will have been noticed that no attempt has been made to place patients into categories determined by the use of comparative terms—that is, "good" or "bad" results—or to give the number of "satisfied" patients. This classification so frequently distorts the truth because it hides it, and it is no substitute for factual statements.

VAGOTOMY AND POSTERIOR GASTRO-ENTEROSTOMY

Routine abdominal vagotomy and posterior gastro-enterostomy with the stoma in the pyloric antrum was carried out.

Follow-up—Ninety-six cases were operated on between 1948 and 1953 inclusive and four in 1954. The average time between the date of operation and the date of this follow-up was two years and nine months. Nine patients did not attend for review; the next nine patients were therefore reviewed.

Biliary Regurgitation

The following were the results of investigation into biliary regurgitation in 100 cases:

Nil	67 patients
Definite	8
(1) 1-1 pint (285-570 ml.) twice a week ..	1 patient
(2) 1 cupful (170 ml.) daily before breakfast ..	1 "
(3) Half a cupful (85 ml.) twice a week ..	1 "
(4) " " (85 ") after fats only ..	1 "
(5) One mouthful three times a day ..	2 patients
(6) " " almost daily ..	2 "
Negligible (less than a mouthful once a week) ..	25 "

Evaluation.—Seven cases more have regurgitated bile after vagotomy and gastro-enterostomy than after partial gastrectomy. In each of these seven cases not more than a mouthful of bile was returned at once. There was no material difference in major biliary regurgitation after partial gastrectomy and after vagotomy and gastro-enterostomy.

Ability to take a Normal-size Mixed Meal

Group A: Seventy-seven patients were able to take a normal-size mixed meal.

Group B: Twenty-three patients were unable to take a normal-size mixed meal.

Evaluation.—Comparing the above figures with those after partial gastrectomy it is clear that there is an overwhelming advantage in favour of vagotomy and posterior gastro-

enterostomy, 45 patients being deprived of their ability to take a normal-size meal by partial gastrectomy as against 23 by vagotomy and gastro-enterostomy.

Ability to take a One- or Two-course Meal

Of the 100 patients under consideration, nine were found to have been deprived by vagotomy and gastro-enterostomy of their ability to take a sweet course. The distribution of these nine patients in the two groups is as follows:

Group A: of the 77 patients able to take a normal-size meal, only one did not take a sweet course.

Group B: of the 23 patients unable to take a normal-size meal, eight did not take a sweet course.

The actual figures obtained were:

Sweet Course			
Group A		Group B	
Yes	69	Yes	13
No	1	No	8
No/No	7	No/No	2

"No/No" indicates that the patient did not take a sweet course prior to the ulcer or after operation. It was found that 69 patients were taking a normal-size meal with a sweet course and eight were not taking a normal-size mixed meal or sweet course.

Evaluation.—The advantage here is overwhelmingly on the side of vagotomy and gastro-enterostomy, 35 patients being deprived by partial gastrectomy of their ability to take a sweet course as against nine similarly deprived by vagotomy and gastro-enterostomy.

Selective Impairment of Digestion

Group A

Selective Impairment of Digestion in 69 Patients Having a Normal-size Mixed Meal With a Sweet Course

Ability to Take	Yes	No	No/No	Uncertain
Milk	52	2	7	—
" puddings	63	3	2	—
Fatty foods	58	8	3	—
Eggs	59	7	3	—
Chocolates	55	5	7	—
Pastries	58	5	6	—

In addition to the above, eight patients did not drink milk and one did not take milk puddings; both could have done so had they wished.

Group B

Selective Impairment of Digestion in Eight Patients Unable to Take a Normal-size Mixed Meal or a Sweet Course

Ability to Take	Yes	No	No/No	Uncertain
Milk	3	5	—	—
" puddings	1	6	1	—
Fatty foods	1	6	—	1
Eggs	3	4	—	1
Chocolates	3	3	1	1
Pastries	2	5	1	—

The selective impairment of digestion in the 100 patients treated by partial gastrectomy and the 100 patients treated by vagotomy and gastro-enterostomy was as follows:

	No Milk	No Milk Puddings	No Fatty Foods	No Eggs
After P.G.	30	32	25	20
" vag. and P.G.E.	7	10	17	14

Evaluation.—These figures show a clearly defined advantage on the side of vagotomy and gastro-enterostomy.

Incidence of Dumping Attacks

The total number of patients with dumping was 12. In six these attacks were not related to meals. This group is constituted as follows: one patient with dumping attacks approximately once a month after exercise; one patient

with dumping attacks twice a week associated with emotion and exercise; one patient with dumping attacks occasionally after emotion; two patients with dumping attacks once a month with no ascertainable cause; one patient with three attacks of dumping in eight months with no ascertainable cause.

In the six patients in whom dumping attacks bore a definite relation to meals the record is as follows: two had dumping after hot milk, one after "horlicks"; one slightly after fatty foods; one after the midday meal irrespective of its nature; and one had two attacks a month, usually after breakfast.

Evaluation.—The incidence of dumping after vagotomy and gastro-enterostomy is less than after partial gastrectomy. The attacks are less often associated with particular foods, and there is therefore not the same necessity to restrict the diet in order to avoid the attacks.

Summary

There is no material difference in the incidence of biliary regurgitation after partial gastrectomy and that after vagotomy and gastro-enterostomy; the incidence of dumping is less after vagotomy and gastro-enterostomy; the outstanding advantage of vagotomy and gastro-enterostomy over partial gastrectomy is in the nutrition of the patient; more patients take a normal-size meal, more patients take a sweet course, fewer patients suffer from a selective impairment of digestion—and the difference in all three points is substantial.

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CLINICAL EVALUATION OF THREE ANTICOAGULANTS IN THROMBO- EMBOLIC DISEASE

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Although anticoagulant therapy is at present widely accepted as being of value in thrombo-embolic disorders, there is less agreement on the best agent for inducing a therapeutic degree of prolongation of the one-stage prothrombin time.

The most commonly used oral anticoagulants in this country are ethyl biscoumacetate ("tromexan") and phenindione ("dindevan"), both of which rapidly produce an effect of comparatively short duration. The former is apt to produce frequent wide fluctuations in the prothrombin time, particularly during the first ten days of treatment (Barker, 1952). Toohy (1953) has reported favourably on the actions of phenindione. A third anticoagulant, cyclocoumarol ("cumopyran"), or 3,4-(2'-methyl-2'-methoxy-4'-phenyl) dihydropyranocoumarin, has become available in this country recently. It was first synthesized by Ikawa in 1942 in Link's laboratory during an investigation of substances chemi-