

TOTAL GASTRECTOMY FOR GASTRIC CARCINOMA: A CLINICAL, RADIOLOGICAL AND LABORATORY ASSESSMENT OF DIFFERENT PROCEDURES AND OF A NEW METHOD OF GASTRIC RECONSTRUCTION

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SUMMARY

Debate continues as to what type of reconstruction, after Total Gastrectomy, might be considered next to perfect. A retrospective analysis of 118 of these operations is carried out by the Author, comparing the experience obtained with 79 reconstructions by a newly developed technique (LYGIDAKIS method), 12 LAWRENCE's pouches, 12 Roux-en-Y esophagojejunostomies, 10 end-to-side esophagojejunostomies and 5 esophagoduodenostomies. Utilizing a physiological test meal (Galactomine 18-Raybar), the Author evaluated 20 long term survivors: 5 with LYGIDAKIS method, 5 with LAWRENCE pouch, 5 with Roux-en-Y reconstruction and 5 with simple end-to-side esophagojejunostomy. Analysing parameters such as development of **dumping**, diarrhoea, pouch emptying time, small bowel transit time and colonic emptying time, conclusion is made about the superiority of the reconstructive technique described in this paper.

RESUMO

GASTRECTOMIA TOTAL NO CARCINOMA GÁSTRICO: AVALIAÇÃO CLÍNICA, RADIOLÓGICA E LABORATORIAL DAS DIFERENTES TÉCNICAS E DE UM NOVO MÉTODO DE RECONSTRUÇÃO GÁSTRICA

A discussão sobre qual o método de reconstrução, post Gastrectomia Total, que pode considerar-se como próximo do ideal permanece em aberto. Uma análise retrospectiva de 118 destas operações é efectuada pelo Autor, comparando a experiência obtida com 79 reconstruções por uma nova técnica (Método de LYGIDAKIS), 12 bolsas de LAWRENCE, 12 esofagojejunostomias em Y de Roux, 10 esofagojejunostomias término-laterais e 5 esofagoduodenostomias. Utilizando uma refeição fisiológica (Galactomine 18-Raybar) o Autor avaliou 20 sobreviventes a longo prazo: 5 com bolsa de LYGIDAKIS, 5 com bolsa de LAWRENCE, 5 com reconstrução em Y de Roux e 5 com simples esofagojejunostomia término-lateral. A análise de parâmetros tais como o aparecimento de **dumping**, diarreia, tempo de esvaziamento da bolsa, tempo de trânsito no delgado e tempo de esvaziamento do cólon permite-lhe concluir sobre a superioridade da técnica por ele imaginada.

INTRODUCTION

Total gastrectomy is of value in a number of clinical situations, but is most frequently used in the treatment of gastric carcinoma where it offers the only chance of cure. The operation carries, however, a not inconsiderable mortality and morbidity, late complications including reflux oesophagitis, post-prandial fulness and discomfort, dumping, diarrhoea, hypoproteinaemia and weight loss, and anaemia.¹⁻⁵

A number of methods of reconstruction after total gastrectomy have been tried in an attempt to minimise these symptoms. Simple end-to-side or en-to-end oesophagojejunostomy (Roux-en-Y) or oesophagoduodenal reconstruction do not provide any form of *gastric* substitute and fail to prevent these complications. Furthermore, there is a reported mortality for these procedures as high as 40%, so that they have been abandoned by most operators.^{1-3,6-8}

A variety of revisional and reconstructive procedures have been reported, all of which attempt to provide the pa-

tient with a substitute for the stomach which will function as a reservoir interposed between the oesophagus and small bowel^{1,7,9,10-26} (Fig. 1). Debate continues as to the relative merits of these procedures, the most successful of which is probably that developed by Lawrence and recommended by others.^{27,28}

This report details 118 patients with carcinoma seen and operated upon between 1964 and 1980, all of whom were submitted to total gastrectomy. Initially, a number of reported methods of reconstruction including end-to-side or end-to-end oesophagojejunostomy, oesophagoduodenostomy, reconstruction by means of a simple Roux-en-Y loop or by a Lawrence type pouch (Fig. 1) were attempted. The Lawrence reconstruction involves the development of a reservoir by folding a Roux-en-Y length of jejunum into a loop and constructing a side-to-side anastomosis of 8 - 10 inches in length between the 2 parallel limbs of the loop. The loop with its so constructed reservoir or pouch is anastomosed to the oesophagus. Disappointment with the results of these procedures led to the development of a new technique.

MATERIALS AND METHODS

During the years 1964 to 1980 inclusive, 118 patients with histologically proven gastric cancer, located in the cardia or upper body of the stomach, were submitted to total gastrectomy (Table 1).

There were 80 men and 38 women (age range 26 - 70 years, mean 63 years). Presentation was usually with mild to severe dyspepsia of recent onset, fatigue and malaise, and all patients suffered from anorexia and weight loss. The length of history ranged from 6 months to a maximum of one year. Overt gastrointestinal bleeding was not unusual and indeed occurred as melaena in 33 cases.

Investigations included a barium meal study in all patients and gastroscopy in the most recent 85 cases. Gastric secretory studies were not performed. Routine haematological tests, serum iron and liver function tests (including serum proteins) were performed in all patients.

In all patients, the specimens removed were sent for histological evaluation. Post-operatively the surviving patients were followed, the survival period ranging from one to 14 years (Table 2). Thus, one year after operation 106 patients were still alive. At follow-up a history was taken, including a detailed history of abdominal pain, anorexia, abdominal fullness, post-cibal discomfort, regurgitation and dumping. A physical examination was carried out and all the surviving patients were weighed, a comparison being made between post-operative weight at intervals (initially at 2 month intervals), pre-operative weight and the pre-illness weight as obtained from the history. These findings were assessed each year and for 14 years in all surviving patients.

In addition in 20 patients from those who survived, a physiological test meal was carried out 6 months and 1, 2, 5 and 6 years post-operatively. There were included 5 patients who had a Lawrence type of reconstruction, 5 with a Roux-en-Y reconstruction, and 5 with a simple end-to-end oesophagojejunostomy. As a physiological test meal a mixture of Raybar, a barium suspension that is resistant to flocculation and Galactomine-18 which is a solution of various basic food ingredients was used. The test meal was carried out for an assessment of the reservoir emptying time, small bowel motility and any potential relation with the occurrence of dumping, diarrhoea, or post-cibal fullness.

Galactomine-18 (Cow and Gate) was used as the food component of the test meal. One hundred grams of Galactomine-18 contains 18gr of protein, 14.4 gr of fat in the form of vegetable oil, 58.3 gr of liquid glucose and 3.5 gr of various mineral salts. The test meal was prepared by mixing 100 gr of Galactomine-18 with water and adding 150 ml of Raybar. The result is a thick creamy mixture with a total volume of 250 ml and containing a good balance of the normal food components. The osmolality of the mixture is 520 mosmol/kg which is hypertonic, but within the range of osmolality expected from stomach contents after a standard meal. The patients were standing during the test meal, which was taken by use of a spoon. The upper alimentary tract was radiographically screened during ingestion of the meal and appropriate undercouch radiographs were exposed. Standard overcouch radiographs of the abdomen were then taken with the patient lying supine immediately after the meal and 15', 30', 45', 60', 75', 120', 180' and 240' later. Radiographs were repeated after this period of time only in those patients in whom the meal was still remaining in the stomach substitute. Additional radiographs were routinely taken in the erect position immediately and at 15' after the meal, but also in the other stated times if there were any prevailing symptoms or if fluid levels were present on the

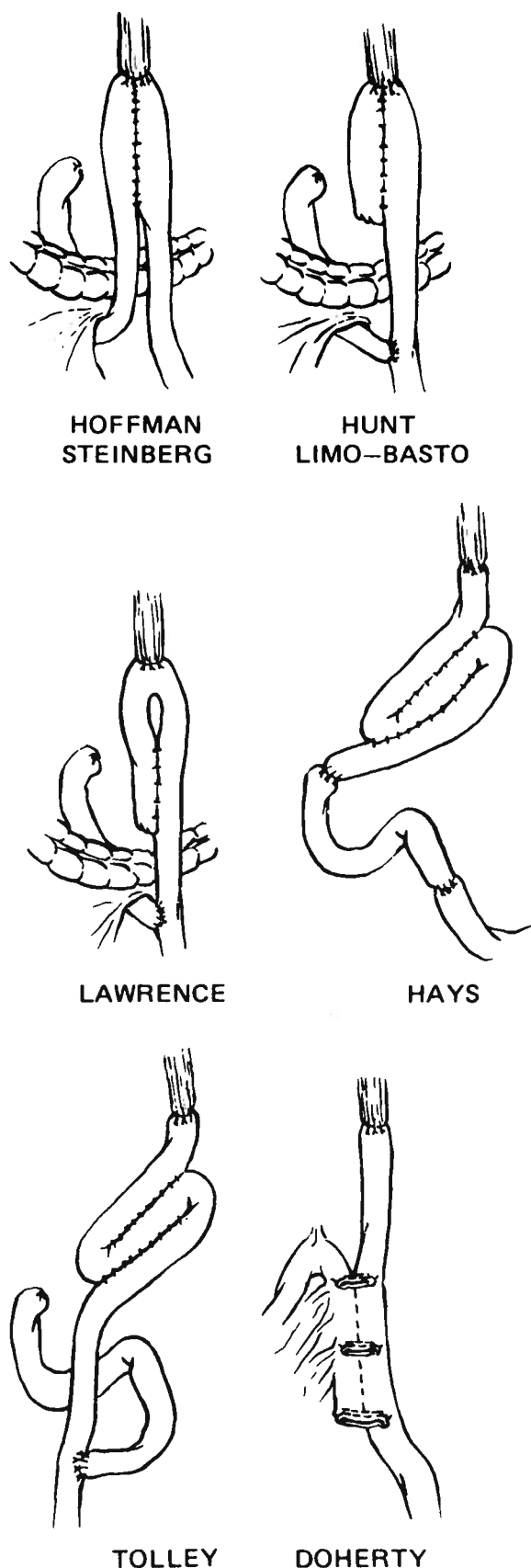


FIG. 1 — Different methods of gastric reconstruction after total gastrectomy.

TABLE 1
RELATION OF THE LOCALISATION OF CANCER TO THE RECONSTRUCTIVE PROCEDURE

Location of carcinome	Nº	New Method	Laurence	Roux-en-y	Oesophago-jejunostomy	Oesophago-duodenostomy
Oesophagogastric junction	51	29	5	7	7	3
Cardia	28	20	4	2	1	1
Body of stomach	39	30	3	3	2	1
TOTAL	118	79	12	12	10	5

TABLE 2
SURVIVAL OVER 14 YEARS

Survival (Years)	Nº of Patients
1	106
2	94
3	80
4	64
5	17
6	16
7	14
8	12
9	10
10	10
11	8
12	7
13	6
14	6

preceding erect radiographs. Paramount importance was given to the prompt and accurate recording of the time of onset, duration and nature of any symptoms which occurred after ingestion of the test meal. The following features were recorded:

- 1) Reservoir emptying time. The reservoir was judged to be empty when only a trace of the meal remained among the jejunal rugae.
- 2) Small bowel transit time. This was the time taken for the head of the barium column to reach the terminal ileum.
- 3) The presence or absence of any dilution of the meal within the small bowel. The signs of dilution were an obvious thinning of the contrast density, blurring of the mucosa pattern and a fuzzy cottonwool appearance. The most pathogenic and most pronounced evidence of excessive intraluminal fluid was the presence of fluid levels within the small bowel.

- 4) The time of onset and the nature of any post-cibal symptoms.
- 5) Any alteration in the morphology, size and appearance of the jejunal reservoir.

OPERATIVE TECHNIQUES

Total gastrectomy was carried out in all patients. It was considered that a potentially curative operation had been carried out if there was macroscopic and histological clearance of tumour at the resection lines, but the procedure was considered to be palliative only if tumour was not completely cleared at surgery, or subsequently shown to be involving the resection line at histological examination (Table 3).

Reconstruction was carried out in 12 patients using the Lawrence technique, in 12 by end-to-end oesophagojejunostomy, in 10 by end-to-side oesophagojejunostomy and in 5 by oesophagoduodenostomy. In the remaining 79 patients, reconstruction was carried out to a Roux loop of jejunum by the new method. The same technique was also used as a revisional procedure in 5 patients who were losing weight and incapacitated 2 - 3 years after an initial Lawrence reconstruction (2 patients) or end-to-side oesophagojejunostomy (3 patients). These groups of patients are shown in Tables 4, 5, 6.

NEW TECHNIQUE

Total gastrectomy is performed (including splenectomy) except for transection of the oesophagus. The specimen is then turned upwards over the costal margin so as to bring the lower oesophagus into the field of operation for later oesophagojejunostomy. The jejunum is then divided 10 - 15 cm beyond the ligament of Treitz and brought up as a retrocolic Roux-en-Y limb. The open end of the jejunum is then closed in 2 layers of sutures and folded upon itself in **hockey-stick** form over a distance of 18 - 20 cm (Figs. 2 and 3). Oesophagojejunostomy is then performed in 2 layers, an outer of interrupted 3/0 silk sutures and an inner layer of 2/0 continuous chromic catgut. In performing this anastomosis the posterior layer is inserted first before division of the oesophagus. After completion of the oesophagojejunostomy

TABLE 3
RELATION OF CURATIVE OR PALLIATIVE PROCEDURE TO THE TYPE OF RECONSTRUCTION

Procedure	Nº of Patients	*Curative Resection	*Palliative Resection
New method	79	59	20
Laurence	12	10	2
Roux-en-y	12	9	3
Oesophagojejunostomy	10	7	3
Oesophagoduodenostomy	5	5	0
TOTAL	118	90	28

*Curative Resection — Macroscopic and histological clearance of tumour at resection lines

*Palliative Resection — Tumour not cleared at surgery or histologically present at resection line

TABLE 4
OPERATIVE GROUPS

	Primary Operation	Revisional Surgery
New method (Lygidakis)	79	5
Laurence	12 (2 revised)	0
Roux-en-y	12	0
Oesophagojejunostomy	10 (3 revised)	0
Oesophagoduodenostomy	5	0
	118	5

TABLE 5
PRE-OPERATIVE DIAGNOSIS IN 18 PATIENTS WITH GASTRIC CANCER

	Nº of Cases	Correct	Equivocal/ Incorrect
Barium meal	118	85	33
Gastroscopy (Visual)	85	80	5
Gastroscopy (Histology)	85	76	9

Barium meal with or without gastroscopy/biopsy — positive diagnosis in 113 patients (95.7%)

TABLE 6
RELATION OF THE LOCAL SPREAD OF CANCER, LYMPH NODE INVOLVEMENT AND DISTANT METASTASES TO THE TOTAL NUMBER OF PATIENTS AND TO THE PROCEDURE PERFORMED

Local Spread of Cancer	New Method 79 Patients	Laurence 12 Patients	Roux-en-y 12 Patients	Oesophago- jejunostomy 10 Patients	Oesophago- duodenostomy 5 Patients
Spleen and pancreas	13	0	0	0	0
Colon	8	0	0	0	0
Liver	4	0	0	0	0
Peritoneum	2	0	0	0	0
Lung	0	0	0	0	0
Lymph nodes	72	6	6	4	3

Total number of patients = 118

FIG. 2 — Diagram to show initial dissection for new procedure.

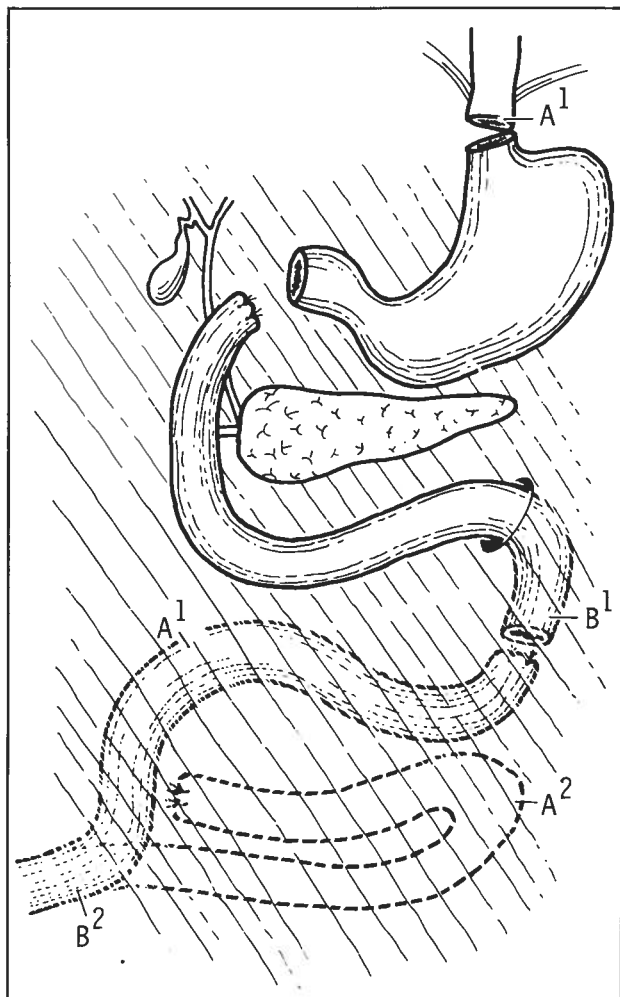
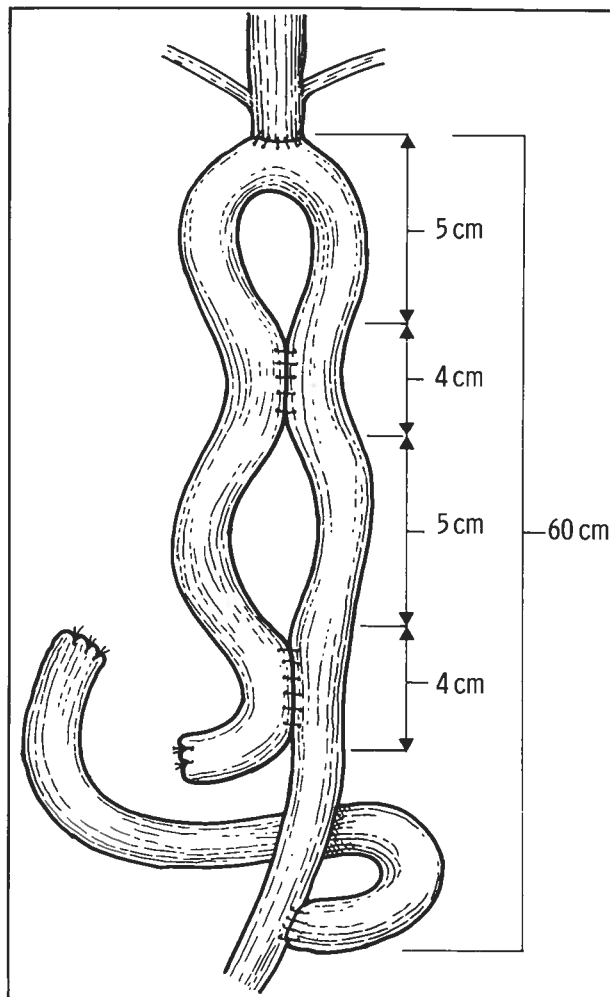


FIG. 3 — Diagram to show method of anastomosis for the new procedure. Notice the long Roux-en-y limb turned on itself over a distance of some 18 cm, 2 anastomoses of 4 cm length being created with a 5 cm gap between each and between the upper of these anastomoses and the oesophagus. A total distance of approximately 60 cm is left between the oesophagojejunal anastomosis and the jejunojunal anastomosis, formed to complete the Roux-en-y reconstruction.



tomy, an anterior flap of the peritoneum is brought down over the suture line and tacked to the jejunum to provide support for the jejunal limb. The pouch is now created. Two side-to-side anastomoses of 4 cm length are made within the folded portion of the jejunum, each anastomosis being separated by a distance of some 5 cm from each other and from the ends of the hockey-stick. These anastomoses are also created in 2 layers. No attempt is made to plicate the jejunum between these anastomoses, so as to leave the maximum opportunity for normal motility. The Roux-en-Y anastomosis is then completed leaving a 50 - 60 cm length of jejunum between the jejuno-jejunal anastomosis and the oesophagus (Fig. 3). Mesenteric defects are closed and the abdomen is then sutured with appropriate drainage in situ.

OPERATIVE RESULTS

The overall outcome for the entire group of patients revealed that 106 survived primary and revisional surgery. The overall mortality was thus 10.2% and the operative mortality 9.75%. Complications occurred in 30 patients, the most significant being dehiscence of the oesophageal anastomosis which occurred in 10, all of whom subsequently died. The detailed operative results in terms of mortality and morbidity are presented in Table 7. Of the 84 patients submitted to the new procedure (5 at revision surgery), 5 died (6%). Three of these deaths occurred after anastomotic leakage, one after massive pulmonary embolism and one as a result of peritonitis consequent on dehiscence of a colonic anastomosis performed after synchronous mid-colonic resection. The overall complication rate in this group was 13%. Although only performed in a limited number of patients, the end-to-end Roux-en-Y anastomosis into the jejunum was associated with a mortality of only 8% and with a low complication rate, there being only one anastomotic leak in 12 cases. The other procedures were associated with a mortality of 17% -30% and with significant morbidity. Taken together, and compared with the new method, the other 4 procedures were performed in 39 patients, 7 of whom (20%) died, all as a result of anastomotic dehiscence.

RESULTS

Our results showed the following findings in our patients, who are divided into four groups according to the reconstruction procedure which had been carried out. (Table 8, Figs. 4,5).

1) Group A: Reconstruction with Lygidakis Technique (5 Patients)

All were symptom-free during the period of the test meal. The jejunal pouch emptied within 2½-3 hours, the small bowel transit time was $110 \pm 15'$, and the colonic emptying time $170 \pm 10'$. The pouch behaved as a temporary reservoir — there being no regurgitation of barium into the oesophagus. The meal appeared to be propelled about the circuit between the side-to-side jejunostomies. There was no pouch dilatation over the time of repeated control, nor was any jejunal mucosal thickening noted (Fig. 6).

2) Group B: Reconstruction with Lawrence Method (5 Patients)

One patient presented the typical picture of dumping and another 3 patients were complaining of severe post-cibal fullness 2 and 3 hours after the ingestion of the meal.

The pouch showed an emptying time of 4 to 6 hours, small bowel transit time was $35 \pm 10'$ for the patient with dumping, and $60 \pm 15'$ for the remainder. The colonic emptying time was $100 \pm 24'$ and $120 \pm 10'$ respectively. In addition severe small bowel dilatation was noted in the patient who experienced dumping, as were fluid levels present in the erect films. It seems likely that fluid levels were seen to appear at the height of the symptomatic phase when dumping symptoms were induced but had disappeared by the time that dumping symptoms had abated. In contrast small bowel dilution was constantly present all over the period that dumping lasted and until its disappearance. The jejunal pouch has been shown with very advanced dilatation, diminished peristalsis and with significant jejunal mucosal thickening. The test was stagnant, and there was regurgitation into the oesophagus in 4 patients. (Fig. 7).

3) Patients with Roux-en-Y Reconstruction (5 Patients)

Three patients had experienced dumping during the test meal ingestion and one had diarrhoea. The emptying time was $60 \pm 10'$, the small bowel transit time $15 \pm 10'$ for those with dumping and diarrhoea and $50 \pm 10'$ for the remaining patient. Colonic emptying time was $36 \pm 10'$ and $80 \pm 20'$ respectively. Fluid levels and severe small bowel dilution were noted in those 4 patients with either dumping or diarrhoea.

4) Patients with Simple Oesophagojejunostomy (5 Patients)

All five patients developed dumping and diarrhoea during the test meal period. The emptying time was $40 \pm 10'$, the small bowel transit time $12 \pm 5'$, and the colonic emptying time $30 \pm 10'$. Fluid levels in the erect films, and small bowel dilution were seen to occur in all patients.

Finalising our results it would appear reasonable to note that in all patients who experience dumping during the period of the test meal, this occurred 5'-10' after its ingestion and was correlated with entry into the small bowel even of a small amount of test meal. Diarrhoea was induced 15' after the ingestion of meal and was associated with the same findings in radiography of fluid levels and severe small bowel dilution. Furthermore in the patient where the test meal provoked symptoms of dumping, post-cibal fullness or diarrhoea, all had similar symptoms following the ingestion of normal food, and no previously asymptomatic patient developed any symptom during the period of the test meal.

DISCUSSION

From our results it seems likely that Galactomine-18 and Raybar meal satisfied the basic requirements for a physiological test meal.

It may well be accepted that it has been proved that the emptying time of stomach substitute is associated with the small bowel transit time and colonic entry time, and that furthermore is related in the majority of patients to the occurrence and incidence of dumping, diarrhoea and post-cibal fullness.

Thus in patients after reconstruction with Lygidakis method where the reservoir emptying time was delayed, but without occurrence of stasis, there was normal small bowel transit time and normal colonic emptying time, and no patient developed any symptoms of diarrhoea, dumping or post-cibal fullness.

In contrast in patient with Lawrence's method of reconstruction although there was a delayed emptying time, it

TABLE 7

COMPLICATION RATE AND MORTALITY IN 118 PATIENTS WHO UNDERWENT, AFTER TOTAL GASTRECTOMY, RECONSTRUCTION OF THE UPPER G.I. CONTINUITY WITH DIFFERENT METHODS, INCLUDING PATIENTS WHO WERE SUBMITTED TO REVISIONAL SURGERY

Procedure	Nº Pts.	Nº Ops.	Pulmonary Embolism	Anastomotic Leak	Colonic Leak	Wound Infection	Subphrenic Abscess	Resp. Infec.	DVT	Op. Mort. %
New Method	79	84	1*	3*	1*	2	1	3	0	6
Lawrence	12	12	2	2*	0	3	0	0	1	17
Roux-en-Y	12	12	1	1*	0	2	0	0	0	8
Oesophagojejunostomy	10	10	0	3*	0	2	0	0	1	30
Oesophagoduodenostomy	5	5	0	1*	0	1	0	0	0	20
TOTAL	118	123	1(1*)	10*	1*	10	1	3	2	9.75

* Complication leading to death

TABLE 8

**LATE COMPLICATIONS AFTER TOTAL GASTRECTOMY FOR DIFFERENT METHODS OF RECONSTRUCTION
CLINICAL ASSESSMENT OF SURVIVORS ONE YEARS AFTER OPERATION**

	No. Pts.	Significant Post-op. Symptoms No.	Dumping	Predominant Post-op. Complaint			Return to Work
				Regurgitation	Post-cibal Fullness	Diarrhoea	
New method	74	5	0	2 mild	1 mild	2 mild	61 (82%)
Lawrence	10	6	2	3	8	1	3 (30%)
Roux-en-Y	11	6	4	2	2	4	0 —
Simple oesophagojejunostomy	7	7	4	5	1	1	0 —
Oesophagoduodenostomy	4	4	3	4	1	1	0 —
TOTAL	106	28	13	16	13	9	64 (60%)

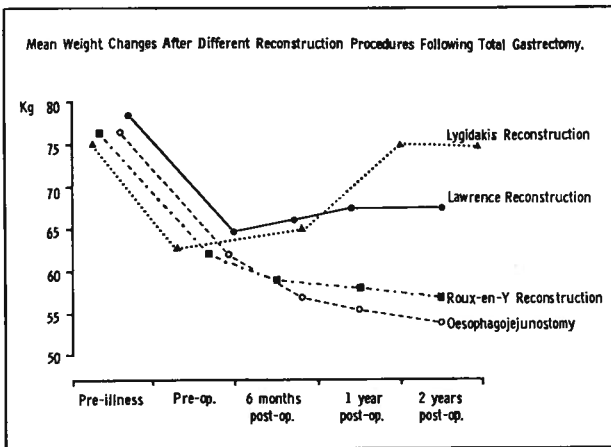


FIG. 4. — Mean weight changes after different reconstructive procedures following total gastrectomy. The pre-illness weight is taken from the history. Weight pre-operatively and at intervals post-operatively is measured.

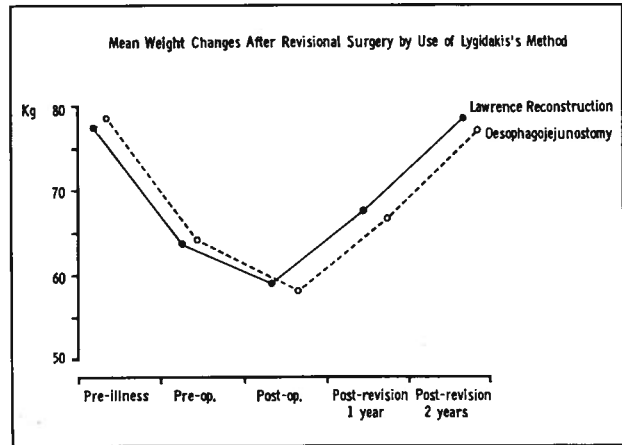


FIG. 5 — Mean weight changes before illness, before initial operation, after operation and then one and two years after revisional surgery using the method of Lygidakis in 5 patients operated upon initially by Lawrence or oesophagojejunostomy procedures (see text). Pre-illness weight is calculated from the historical weight obtained from the patient at interview.

FIG. 6 — Barium meal appearance after reconstruction using the new technique one year after surgery. The film is taken 2 hours after administration of Barium showing ordered emptying and there is no pouch dilatation.

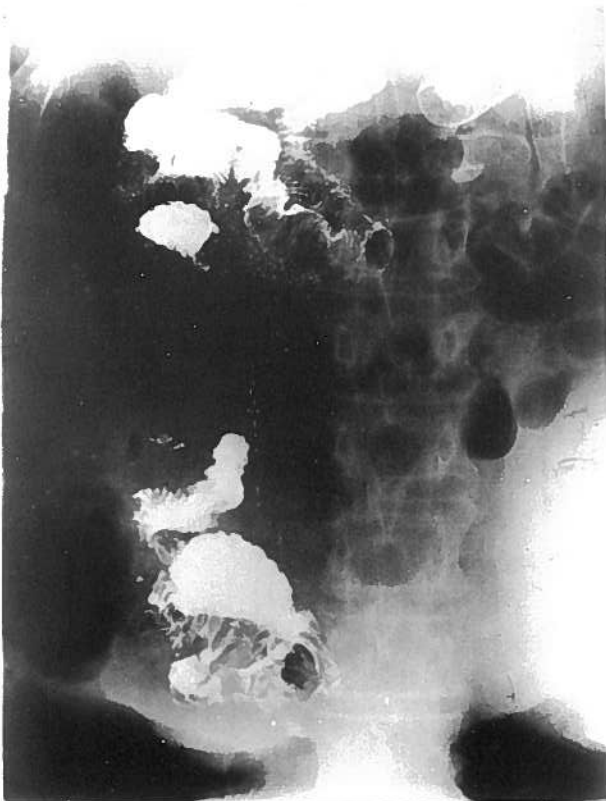


FIG. 7 — Barium meal study obtained one year after surgery in a patient with a Lawrence type reconstruction. Note that there is pouch dilatation, coarse mucosal folds and that emptying is occurring in a precipitate manner.



proved to be more than desirable and resulted in pouch dilatation with alterations in jejunal mucosa and stasis of the meal. There the symptoms of post-cibal fullness were prominent and the patients who developed dumping had an accelerated small bowel transit time, presumably due to jejunal loop dilation and to its mucosal alterations.

This hypothesis is supported from our findings from the radiographs where the observed small bowel changes corresponded with the induction and duration of symptoms, and have to be attributed to small bowel hypersensitivity, to moderately hyperosmolar substances, as a result of an induction of some abnormal responses from the bowel.

Finally the high incidence of dumping and diarrhoea in patients who underwent a reconstruction by Roux-en-Y or simple oesophagojejunostomy, and where emptying time, small bowel transit time and colonic emptying time were accelerated, gives evidence of the relation of those elements for at least the patients in whom total gastrectomy is carried out.

There remains no doubt that the above evidence poses the demand for the need of reconstructive procedures after total gastrectomy, where indeed a stomach substitute to function as a reservoir is warranted. From the results of this study Lygidakis's method of reconstruction proved to fulfill the above goal. Indeed it has been shown to be carried out without increased mortality or morbidity and with satisfactory results. There was a delayed but effective emptying time without dilatations within the reconstructed pouch. These findings were in striking contrast to the other procedures where emptying was either delayed with regurgitation and low dilatation of jejunal limb, or complicated by precipitate emptying.

The precise reasons as to why the new procedure appears effective are difficult to elucidate. It may well be that the creation of the two anastomoses allows the development of a circuitous peristaltic movement consequent on the maintenance of normal contractility between the two stomata. This circuitous movement appears to delay passage of foods sufficiently without allowing undue delay. The radiological studies reported in this study support this view but experimental work would be necessary to assess electrical activity and motility to prove the point. Support for the hypothesis that normal contractility produces the circuitous movement suggested can be found in the literature (29,30).

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