

aldosterone (Simpson *et al.*, 1953), which may not be dependent on pituitary control, seems to be adequate for the patient's normal needs; because severe sodium depletion, such as occurs regularly in untreated Addison's disease, is an unusual feature of adrenal failure secondary to hypopituitarism, unless it is provoked by infections, gastroenteritis, or surgical stresses (Peters *et al.*, 1954; Caughey and Garrod, 1954). This conclusion is supported by the results of Luetscher and Axelrad (1954), who found normal amounts of aldosterone in the urine of two cases of severe hypopituitarism, although this steroid was absent in the urine of patients with primary adrenal insufficiency. It is not surprising, therefore, that pure water retention without significant sodium depletion can occur in hypopituitarism. That it may not be uncommon is suggested by reports of very low plasma sodium concentrations, without evidence of dehydration or crisis, in patients with this condition—for example Bartter *et al.* (1950), Waterhouse *et al.* (1952), Peters *et al.* (1954), and Aber *et al.* (1954)—a state of affairs which has usually been attributed to sodium depletion.

As though to protect themselves from water retention, and because of their lowered metabolism, which reduces the solute load to the kidneys, patients with advanced hypopituitarism usually drink very little, and their urinary volumes are correspondingly small (Case 1 was exceptional in that her urine output, when not on cortisone, was around 1.5 litres a day). Admission to hospital may present a definite hazard to such patients because of a tendency to force the fluid intake, especially when urine output is low. This should be avoided by special instructions to the nursing staff.

Daily weighing of the patient is the simplest way to detect large changes in water balance. A gain in weight accompanied by a fall in plasma sodium concentration suggests primary water retention. It should be stressed that dangerous hypotonicity can exist without clinical signs, and that peripheral oedema is not a manifestation of primary water retention (although the two conditions may occur together).

Once the danger of forcing fluids in hypopituitary patients is recognized, it follows that water-excretion tests are unwise when plasma sodium estimations show that significant hypotonicity already exists. If the plasma sodium exceeds 130 mEq per litre the diluting effect of a litre or so of water is unlikely to cause untoward symptoms. Since cortisone acts rapidly to cause water excretion in adrenal failure, it should be available for use whenever water-excretion tests are performed in these patients.

Conclusions and Summary

An abnormality of water balance is described in two patients with anterior hypopituitarism. Although their intake of fluids was not forced, they retained water in excess of electrolytes, causing dilution of the body fluids and symptoms of water intoxication. The diagnosis was suggested by a gain in weight and a very low plasma sodium concentration. When cortisone was given there was a prompt water diuresis and the plasma sodium concentration rose to normal, though there was little change in the total body sodium. Water retention may not be very rare in anterior hypopituitarism, although it appears to have been reported as such in only one other case (Whittaker and Whitehead, 1954).

In addition to chronic water retention, acute symptoms of water intoxication, including nausea, vomiting, extreme prostration, mental confusion, and stupor, were precipitated by water-excretion tests of adrenal function. This untoward effect of the test probably occurred because there was already excessive dilution of body fluids which was not recognized when the tests were performed. To avoid this complication, a water-excretion test should not be carried out until the plasma

sodium concentration is known. If symptoms due to water retention occur in patients with hypo-adrenal function, cortisone should be given, whereupon the excess water will be excreted rapidly.

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RESULTS OF PARTIAL GASTRECTOMY IN TREATMENT OF PEPTIC ULCER

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Partial gastrectomy has now gained general acceptance as the operation of choice in the treatment of gastric ulcer, and although it is widely used in the treatment of duodenal ulcer its results therein are not so universally acclaimed. Because of its wide usage, much information has accumulated about the effects of the operation, particular attention being focused on the various disturbing after-effects produced.

This investigation was begun in an attempt to assess the value of the operation, and to determine whether partial gastrectomy was capable of relieving the patient of his ulcer symptoms, freeing him from irksome dietary rules, and restoring him to a satisfactory economic life.

Method of Follow-up

This survey is based on a personal follow-up of cases of peptic ulcer submitted to gastrectomy of the Poly type in one surgical unit in the years 1940 to 1951 inclusive. Of 481 patients surviving partial gastrectomy, both elective and emergency, 23 were found to have died of intercurrent disease. Of the remaining 458, 415 (90.6%) were traced and interviewed. Of these, 379 were interviewed personally by one of us with the aid of an agreed schedule of questions, and the results were graded jointly. Information regarding 36 patients who lived too far away to travel was obtained through the courtesy of their own practitioners. Because mild post-gastrectomy symptoms are common in the immediate post-operative period and usually improve or disappear

during the succeeding six months, no patient was interviewed until at least a year after operation.

An overall assessment of the success, or otherwise, of partial gastrectomy was made by classifying the results into three categories: "good," when a good or excellent result had been obtained; "satisfactory," when the patient was substantially improved in comparison with his pre-operative state; and "poor," when no marked improvement had occurred or the patient's condition was worse than before operation. Each patient was asked for an opinion regarding the success of the operation, and the observer made a separate estimate based on all aspects of the patient's health. No result was adjudged to be "poor" on account of anaemia alone, as this is in most cases correctable by the administration of iron. Seven patients who developed tuberculosis were regarded as "poor" results on the assumption of a close relationship between this disease and gastrectomy.

Clinical Assessment

The results are presented in Table I, and the number of patients satisfied with their post-operative state is seen to be very impressive. Only 16 patients out of 415 considered

TABLE I.—Clinical Assessment

Result	Patient's Opinion	Observer's Assessment
Good	338 (81.4%)	266 (64.1%)
Satisfactory	61 (14.7%)	99 (23.9%)
Poor	16 (3.9%)	50 (12.0%)

that they had obtained no benefit from partial gastrectomy. The stricter criteria of success adopted by the observers produce a different picture, and 50 (12%) were considered to have had a "poor" result from operation.

On analysis there was found to be no significant correlation between the clinical result and such factors as the age of the patient, the duration of ulcer symptoms, and the site of ulcer; nor did variations in operative technique influence the outcome, as there was no significant difference in result between 276 antecolic and 131 retrocolic anastomoses.

In comparing the sexes (Table II) it was found that the number classified as "poor" was essentially the same, but fewer of the women were regarded as having a "good" result, a number of otherwise excellent results being classified as "satisfactory" owing to anaemia.

TABLE II.—Result in Relation to Sex of Patient

Sex	No. of Patients	Result as Assessed by Observer		
		Good	Satisfactory	Poor
Male	355	231 (65.1%)	81 (22.8%)	43 (12.1%)
Female	60	35 (58.3%)	18 (30.0%)	7 (11.7%)

Operative Mortality

With increasing experience of the operation and better pre- and post-operative management (Illingworth, 1953) it was found that the mortality rate of the operation gradually improved throughout the years of the series, and it is now 3.3% (214 cases, 1951-2).

Of all the factors investigated which might influence the mortality rate, the age of the patient was found to be the most important. Over 50 years of age the rate rose steeply and cardiac and respiratory causes of death contributed largely to the higher mortality in the older patients. The duration of ulcer history, the sex of the patient, and the type of operation performed did not affect the mortality rate to a marked extent.

Tuberculosis after Partial Gastrectomy

It is suspected that there is an increased liability to pulmonary tuberculosis after partial gastrectomy. Attention was focused on this possibility by Pulvertaft (1952), who

found that of 23 deaths subsequent to operation 8 were due to tuberculosis. The occurrence of such deaths had previously been noted without comment by other authors (Bruusgaard, 1946; Ransom, 1947), but none found such a high incidence as did Pulvertaft.

In the present series there have been 8 deaths due to pulmonary tuberculosis in a total of 23 intercurrent deaths. In addition, 8 patients still alive were found to have had pulmonary tuberculosis, and in 6 of these the lesion was still active. Thus in 481 patients surviving operation, 16 (3.3%) are known to have developed active tuberculosis.

Such a figure would appear to be definite evidence of an increased liability to tuberculosis in patients who have undergone partial gastrectomy. It is therefore suggested that the presence of active tuberculosis in an ulcer patient should be accepted as an absolute contraindication to partial gastrectomy, and the presence of a latent lesion should give rise to serious consideration of the advisability of this operation. Since 1952 a pre-operative chest film has been taken routinely in this unit, and this would appear to be a wise precaution.

The reason for the increased liability to tuberculosis is not known, but Pulvertaft's suggestion that it is "related to the recognized loss of weight following gastrectomy" seems very reasonable. There is little doubt that the nutrition of many of these patients is inadequate, and this could be the determining factor in the development of tuberculosis.

Anaemia after Partial Gastrectomy

It is generally accepted that macrocytic anaemia with a megaloblastic bone marrow is very rare after partial gastrectomy, though more common after total gastrectomy. Only one case of atypical macrocytic anaemia occurred in this series, and we hesitate to label it as a verified case. Iron-deficiency anaemia, on the other hand, is far from uncommon and is generally thought to be due to the inadequate absorption of food iron after partial gastrectomy.

In this investigation the haemoglobin level, as measured by the Sahli method, was ascertained at each interview, and cases with values below 70% had a full haematological examination carried out. The results are plotted separately

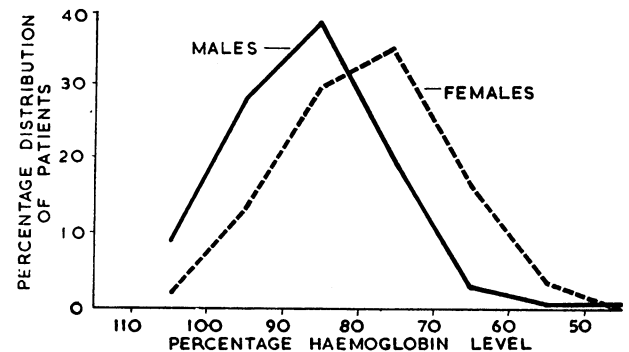


FIG. 1.—Haemoglobin levels. (Sahli: standard 14 g. per 100 ml.)

for males and females in Fig. 1. It will be seen that the haemoglobin level is subnormal in the majority of patients, especially females. The values for men tend to be situated in the range 80-95%, and for women 70-90%.

It is suggested that diminished iron absorption after partial gastrectomy produces, in general, a haemoglobin level lower than that of normal individuals. In some cases symptoms of tiredness or shortness of breath are produced, especially in women in whom the additional factor of menstruation is involved. The administration of iron by mouth is usually curative, and those who do not respond adequately can be controlled by periodic injections of intravenous iron.

Loss of Weight after Partial Gastrectomy

The occurrence of loss of weight after partial gastrectomy is accepted by most authorities (Everson, 1952; Pulvertaft, 1952), the degree of such loss depending on the standards adopted. In this survey, in each patient the post-operative

weight at the time of interview has been compared with his normal weight in health. The findings are presented in Table III and in Fig. 2, the change in weight being indicated according to the formula

$$\frac{\text{Present weight}}{\text{Normal pre-illness weight}} \times 100.$$

TABLE III.—Change in Weight

Change in Weight	Males	Females
+5% or more ..	27 (8.6%)	4 (7.8%)
-5% to +4% ..	114 (36.2%)	14 (27.5%)
-6% to -10% ..	81 (25.7%)	8 (15.7%)
-11% to -15% ..	56 (17.8%)	14 (27.5%)
-16% to -20% ..	30 (9.5%)	6 (11.8%)
-20% or more ..	7 (2.2%)	5 (9.8%)

The change in weight was calculated by expressing the present weight as a percentage of the normal pre-illness weight and thereafter noting the percentage gain or loss.

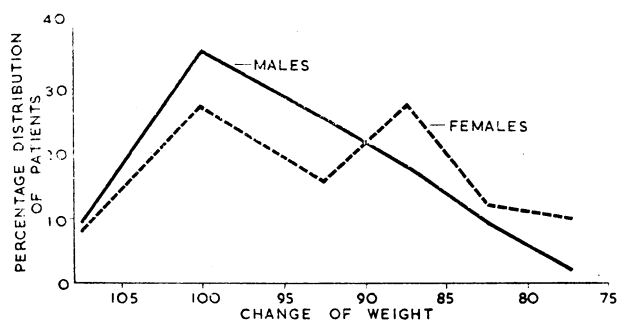


FIG. 2.—Weight change after partial gastrectomy

$$\frac{\text{Present weight}}{\text{Normal pre-illness weight}} \times 100$$

If it is accepted that a 5% loss of weight is within the limits of normality, 44.8% of males and 35.3% of females regained their pre-illness weight. This compares with Pulvertaft's figures of 53.9% for males and 37.2% for females. A substantial degree of weight loss (more than 10%) is noted in 29.5% of men and 49.1% of women. Such figures leave no doubt that loss of weight after partial gastrectomy is a real entity, and many patients are seriously disturbed by it.

Recurrent Ulceration

The frequency of recurrent ulceration after partial gastrectomy would appear to depend on the level of gastric resection (Visick, 1948). In this unit resection is performed above the lowest of the vasa brevia, and the gastric remnant is a tubular pouch about 2 in. (5 cm.) wide and 6 in. (15 cm.) long. With such a resection, acid secretion has been found to be negligible or absent, and, accordingly, the risk of recurrent ulcer is slight. In this series, recurrent ulcer was proved in only 4 out of 438 partial gastrectomies. Two of these were demonstrated by gastroscopy; one patient died from a gastro-jejuno-colic fistula and the fourth from recurrent haematemesis. Ulcer has been suspected on clinical grounds in another seven patients, but a full investigation, including laparotomy in two, has proved negative. In none of these patients has the pain responded to ulcer therapy, and it is thought that the symptoms are not due to ulcer.

This gives an ascertained recurrence rate of 0.9%. This accords with Visick's (1948) experience of measured radical gastrectomy (an even more extensive resection), when he noted no recurrence in 200 patients. If a less extensive resection is preferred in view of the probable lesser operative risk and the lower incidence of post-gastrectomy symptoms (Pulvertaft, 1952), a higher recurrent ulcer rate must be accepted—for example, 3.7% (Visick, 1948).

Post-Gastrectomy Symptoms

Estimates of the incidence of these symptoms vary enormously with different observers up to the high figure of 75% (Muir, 1949). Symptoms do occur in many patients

soon after operation but tend to diminish or disappear within the first six months, and in some cases are acknowledged only after careful inquiry. As our patients were not interviewed until at least a year had elapsed since operation, it was thought that a reasonable estimate of the incidence of symptoms was possible.

The following classification into four categories was adopted: (a) no symptoms; (b) fullness only—that is, a sensation of epigastric fullness induced by meals of small quantity (two small courses or less) without other symptoms; (c) "dumping"—mild or severe; and (d) bilious vomiting—mild or severe. Frequent overlap was found between the latter two categories.

Our estimate of the frequency of these symptoms is presented in Table IV. Severe symptoms were found to occur in 48 (11.8%), and consisted of severe dumping or severe

TABLE IV.—Post-gastrectomy Symptoms in 408 Patients

Symptoms	Males	Females	Total
Nil	184	26	210
Fullness only	57	10	67
*Dumping { Severe	17	4	21
{ Mild	40	6	46
*Bilious vomiting { Severe	26	4	30
{ Mild	32	9	41

* Overlap between these two categories was relatively common.

bilious vomiting or both. Milder symptoms were more common but on the whole relatively unimportant. From a study of the results of other authors (Butt *et al.*, 1948; Visick, 1948; Capper and Butler, 1951; Goligher and Riley, 1952) it would seem reasonable to assume that the incidence of severe symptoms is in the region of 5 to 10%. Unfortunately, it often proves difficult to relieve this minority of their symptoms, and, although a variety of medical and surgical remedies have been tried, the results on the whole are disappointing.

Hypoglycaemia and Vitamin Deficiencies

Hypoglycaemia is generally accepted as the cause of late symptoms two to three hours after a meal. Both the incidence and the resultant disability were found to be of minor importance in this series.

Vitamin-C deficiency was seen in one of our cases, and vitamin-B deficiency occurred in 17 patients, mainly in the form of cheilosis and glossitis. No gross deficiencies were noted such as were recorded by Wells and Welbourn (1951), and response to treatment was satisfactory.

Economic Results of Partial Gastrectomy

After discharge from hospital, usually 10 days after operation, patients are encouraged to return to their original work as soon as they are reasonably capable of so doing. Those performing heavy manual labour naturally tend to restart after a longer period and sometimes have to change to a lighter occupation. It is highly desirable that patients should resume work as soon as possible, both for economic and for psychological reasons.

From Table V it is seen that convalescence need not be unduly prolonged, as 84.3% were able to resume full work within six months. Only 3% of patients have failed to

TABLE V.—Time of Return to Work after Operation: 395 Patients

Time of Return after Operation	No. of Patients
1 month	38 (9.6%)
2 months	109 (27.6%)
3 months	100 (25.3%)
4-6 "	86 (21.8%)
7-9 "	20 (5.1%)
10-12 "	13 (3.3%)
Over 12 months	17 (4.3%)
No return to work	12 (3.0%)

return to work at any time since operation, though a larger number (7.3%) were not working at the time of the survey for various reasons—for example, unemployment, inter-current illness, etc.

If partial gastrectomy is to be regarded as a satisfactory operation, patients must not only return to work within a reasonable period but be able to retain their jobs in competition with other workers. That they are eminently capable of remaining in employment is shown by Table VI, in which

TABLE VI.—Loss of Working Time (Male Workers)

Time Lost	Year Before Operation	Year Before Follow-up	
		All Workers	Heavy Workers
Nil	21.6%	79.9%	84.0%
1 month	16.6%	6.1%	6.4%
2 months	13.4%	4.3%	5.3%
3	15.3%	1.2%	—
4-5	21.3%	1.8%	1.1%
7-9	7.3%	2.4%	3.2%
10-11	4.5%	4.3%	—

the amount of work lost in the year prior to interview is recorded. Little or no work had been lost by 79.9%, and, indeed, many of these had never lost even a day since their return to work. In fairness, it must be admitted that some with post-gastrectomy symptoms were fortunate that they were able to take things easily after meals.

To illustrate the improvement in economic status after operation, a comparison is made of the loss of work before and after operation (Table VI). The comparison is impressive and indicates the economic value to the patient of a satisfactory partial gastrectomy. So satisfied with these results are the patients that the annoyance of mild symptoms is usually ignored.

The ability of heavy manual workers to perform their original job was next investigated. Various occupations were classed as "heavy" (involving heavy manual labour or requiring physical exertion beyond that of the average worker) or "light" (sedentary work or work requiring relatively little physical effort), and the class of work to which each patient returned was noted. As is seen in Table VII,

TABLE VII.—Return to Work after Operation: 134 Heavy Workers: 261 Light Workers

	Heavy Workers	Light Workers
Return to original or equivalent work	97 (72.4%)	220 (84.2%)
.. .. . lighter work	30 (22.4%)	19 (7.3%)
Unemployed (labour market, other health reasons, etc.)	6 (4.5%)	14 (5.4%)
Unemployed (due to post-gastrectomy symptoms)	1 (0.7%)	8 (3.1%)

72.4% of heavy workers returned to their former occupation or to one involving equivalent or, in some cases, even heavier duties. Not only do the majority of heavy workers return to their former occupation, but they lose surprisingly little work after they have restarted (Table VI). From this evidence it is seen that the majority of heavy workers can be restored to a satisfactory economic life by partial gastrectomy.

Discussion

The satisfaction expressed by the large majority of patients with the results of partial gastrectomy underlines its value, and the low percentage of dissatisfied patients (3.9%) is reassuring. Unfortunately, those patients frequently do not respond to treatment, and this gives grounds for disquiet when considering the results as a whole. A large number (29.4%) are troubled by mild or severe post-gastrectomy symptoms, but they usually feel that these are tolerable by comparison with the disabling pain of ulcer.

The attraction which gastro-enterostomy still holds for the surgeon lies in the lower mortality of the operation and the rarity of symptoms of "dumping," bilious vomiting, loss of weight, and anaemia, but the price paid in recurrent ulceration is high. In spite of this, gastro-enterostomy still has a place in the treatment of duodenal ulcer. Because women are more liable to anaemia and weight loss after partial gastrectomy, and the severity, though not the inci-

dence, of stomal ulcer symptoms after gastro-enterostomy is less in women than in men (Clark, 1951), it is possible that the latter operation is to be preferred in females. Furthermore, in both sexes over 50 years of age the risk of stomal ulcer after simple anastomosis is less than average (Clark, 1951), and, as the mortality of partial gastrectomy rises so definitely with age, the simpler operation would appear to be preferable in older people.

In the largest group of duodenal ulcer patients—namely, adult males between 20 and 50 years of age—the risk of recurrent ulceration is such that it is considered that an extensive partial gastrectomy is desirable. In view of the evidence presented in this investigation, the results to be expected are good.

Even in those who do well, however, it is felt that something is lacking. Nutrition is substandard. In the majority the intake of food is limited to a less than average size of meal, and in some there is deficient absorption of fats with the occurrence of borderline fat absorption or actual steatorrhoea. The extent of the deficiency in the individual patient is indicated by the degree of weight loss, which is substantial in nearly 50% of cases. The absorption defect is also evident in the case of iron and vitamin B. In most cases absorption of these is sufficient to meet normal requirements, but in some a clinical deficiency results.

From the evidence of deficient absorption of proteins and fat (Wollaeger *et al.*, 1946), the tendency to loss of weight; the frequent presence of a subnormal haemoglobin level (Fig. 1), and the relatively frequent occurrence of vitamin deficiencies, it seems to us that a state not of malnutrition but of subnormal or substandard nutrition exists in a considerable number of cases after partial gastrectomy. This seems likely to be the precipitating factor in the development of tuberculosis or the reactivation of a quiescent lesion.

Summary

An assessment of the value of partial gastrectomy in the treatment of peptic ulcer is presented, based on a personal follow-up of cases operated on between 1940 and 1951. Particular attention was paid to the effect of the operation on the patient's working capacity, and the incidence of pulmonary tuberculosis, recurrent ulceration, loss of weight, anaemia, and post-gastrectomy symptoms was investigated.

Our thanks are due to Professor C. F. W. Illingworth for giving us access to the records of all these cases in which partial gastrectomy was performed in his unit in the Western Infirmary, Glasgow, and also for his advice and encouragement throughout this investigation. We are grateful to Miss Murray, the secretary of the Peptic Ulcer Clinic, for valuable clerical assistance.

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The Second Panhellenic Congress of Hygiene was held in Athens from December 5 to 11, 1954, under the honorary chairmanship of the Minister of Social Welfare, Dr. CHRISTOS S. SOLOMONIDES. Among the 500 who attended were members of the Academy of Athens, the University of Athens, the Athens School of Hygiene, the Panhellenic Medical Association, and the Athens Medical Association, together with representatives of public health, social welfare, and engineering.