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PARTIAL GASTRECTOMY A REVIEW OF 320 CASES

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In 1879 Pean performed the first gastrectomy; two years later Billroth reported the first successful case of pylorotomy and Wölfler did the first gastro-enterostomy, following the suggestion of Nicoladoni. Thus surgery entered into competition with medicine in the treatment of gastric lesions, and the intervening years have seen successive waves of opinion in favour of one or other form of treatment follow one another with such bewildering rapidity that it would take a medical Einstein to produce a formula which might lead to a conclusion unbiased by the particular mental standpoint of the observer.

In the past ten years there have been two peaks of medical interest—first, the reintroduction of intensive alkalinization, and recently, following the work of Aron, treatment by histidine. On each of these occasions the responsible surgeon and the conscientious practitioner must have felt at a complete loss to know what advice to give their patients, for who would dare advocate operative measures if the lesion could be permanently cured by simple dietetic and medicinal means? In the former instance the dilemma was solved by the passage of time, as surgeons found that most of the cases they were called upon to handle had already had a course of alkaline treatment. We are even now passing into a similar stage with regard to histidine, but its introduction is too recent to allow of any *ex cathedra* statement.

For this reason it seemed that the present was a suitable time to review the position of gastrectomy, but I was influenced in this decision by two other factors: the passing of the three hundredth case provided a convenient milestone and a sufficiency of material to reduce statistical errors to a comparatively small amount; in addition there was the desire to answer certain correspondence that followed the publication (Lake, 1928) of a much smaller series of cases in which a fairly high percentage of successful results was claimed. Thus Hurst (1928) commented: "Experience shows that the 'last' results—that is, after an interval of ten years or more instead of five years or less—would give a much greater number of unsatisfactory results." I have found it difficult to curb my impatience while waiting for the necessary interval to elapse which should provide the answer to this criticism, but I am now in a position to include a fair number of cases of over ten years' duration in this review. As will be seen later they fortunately do not support these gloomy prognostications.

The practitioner cannot be expected to be intensely interested in the technical details of the operation, however important to the surgeon they may be, and so in this article I shall limit the scope to a consideration of the effects of the operation, the results achieved, the risks involved, and such views of the aetiology of ulceration as have arisen from a study of the cases.

The total number of operations reviewed in the series is 320; so far as possible we have attempted to follow the cases for long periods and to carry out such post-operative investigations as appeared necessary or likely to provide information upon particular problems. The "follow-up" system has not been as efficient as I had hoped; in particular the industrial and financial crisis of 1932, with its consequent movements of the population, had a marked influence upon the continuity of the records. The number of cases followed for over five years is thus reduced; but this does not of course affect the immediate statistics relative to mortality, etc. A statistical study of the available figures has been made from many different angles, but only those will be given here which bear upon the particular points under consideration.

The lesions for which the operation has been performed may be divided into ulcers (gastric, duodenal, and pyloric), jejunal anastomotic ulcers, and carcinoma. The subdivision of ulcers into three instead of the more usual two types is a method which I have for long adopted, on account of the fact that in many large ulcers it is impossible to say on *prima facie* evidence where they arose. Commonly they are assumed to be duodenal, since gastric ulcers on the pyloric ring are held to be rare. I should have regarded this point as of but small significance had it not been that the mortality statistics quite unexpectedly showed it to be of some importance.

Lesions for which Partial Gastrectomy was Performed

Gastric ulcers ..	..	..	..	..	..	115
Pyloric ulcers ..	..	..	..	..	..	56
Duodenal ulcers ..	..	..	..	..	..	71
Jejunal ulcers ..	..	..	..	..	..	27
Carcinoma ..	..	..	..	..	..	51

320

Such a list, however, fails to indicate that some of the gastric ulcer cases had progressed to hour-glass contraction (eleven cases); that some of the pyloric and duodenal ulcers had caused obstruction with dilatation of the

stomach (twelve cases); and that, apart from cases of jejunal ulcer, several had had previous gastric operations (perforation ten cases, gastro-enterostomy eight cases, local excision two cases). Nor does it show what, in my opinion, is a much more important feature, especially from the aetiological point of view—namely, that in a considerable proportion of instances the ulcers have been multiple.

I have previously pointed out that the surgeon whose practice includes but few gastrectomies is unlikely to be impressed by the frequency of multiple ulceration, since he has no opportunity of examining carefully the mucosa of the stomach but sees or feels merely the ulcer which is most active at the time of operation. Investigation of the parts removed by gastrectomy demonstrates that multiple ulceration has occurred in 40 per cent. of cases and that the combination of gastric and duodenal ulceration is by no means uncommon. Usually one ulcer only is active and the others are represented by thin scars, which give no indication of their presence on the exterior. By many the aetiology of duodenal and gastric ulceration is thought to be separate, but this view cannot be held if these findings are recognized. The only logical standpoint would seem to be either that one is dependent upon the other or that both are due to some common cause. While studying this series it has at times appeared that there might be some sequence of events, the duodenal ulcer with its higher acid curve preceding the gastric ulcer with its lower curve, but the observations have been of too vague a nature to enable any definite deductions to be drawn. Mills's (1917) studies of bodily habitus in relation to disease have led to the suggestion that the broad-chested, active, hypersthenic type, forceful both mentally and physically, is prone to the development of duodenal ulcer, while the asthenic individual tends to develop gastric ulcer. The theory is an intriguing one, and fits in well with modern ideas of physiological types, but there is little indication in this series that more than a small proportion of the cases conform to these types; many of the duodenal ulcers occurred in asthenic types. The theory is probably fundamentally correct, but the exigencies of modern civilization so complicate the issue that in practice it is of little value as a guide. Indeed the frequency with which gastric and duodenal ulcers are found in the same case shows that Mills's ideas can only be applied as a statistical approximation when large numbers are under consideration.

Aetiology

It would be as well here to consider one or two points in connexion with aetiology. There seems to be a general consensus of opinion among physicians and surgeons alike that eventually peptic ulceration will be treated by medicinal, or possibly by prophylactic, measures. This stage will not, however, be reached until more knowledge of the aetiological factors is obtained.

There are few manipulations to which the experimental animal can be subjected which do not produce a lesion of the gastric mucosa; injections of drugs, toxins, cytolysins, irritants, bacteria; excision of adrenals, thyroid, liver; interference with the nerve supply or with the central nervous system; changes in the blood supply or its composition; traumatization of the mucosa; production of pyloric stenosis, and other operative procedures. These methods, however, cause acute ulcers, which heal so rapidly as to make experimental observations difficult. Mann and Williamson (1923), by experimentally altering the normal relations of the alimentary canal, were able to produce chronic ulcers which were attended with the

complications seen in human cases, notably haemorrhage and perforation. It must be stressed that great caution is necessary in drawing analogies between chronic ulceration in human beings and that in experimental animals, for in the latter profound metabolic changes must result from disturbing the normal relation of the stomach to the intestine. Following upon this work Aron (1933) conducted experiments which seemed to show that the duodenum supplied an important digestive element, the absence of which causes deprivation of the acid amines essential to life. The final stages in the digestion of proteins into simple amines is brought about not by the pancreatic juice but by the duodenal secretions. The amines which cannot be synthesized in the body are chiefly lysin, tryptophan, and histidine. Aron found that of these histidine could prevent ulceration in dogs subjected to the Mann-Williamson operation. Subsequent clinical trial with histidine has produced conflicting results. My own experience does not support the claim that histidine has a curative effect in cases of peptic ulceration. Many patients come to operation who have had several courses of this treatment. Apart from this, experimental work by Morton (1927) is in direct opposition to Aron's hypothesis that histidine protects the mucosa from attack by the gastric juice. Morton's researches, indeed, support the theory that the acid secretion is the most important single aetiological factor in peptic ulceration, combined with the trauma of forcibly ejected gastric contents—a theory suggested by Bland-Sutton many years ago. Experiences with cases of gastro-colic fistula, almost the equivalent in human cases of the Mann and Williamson experiment, are also in direct conflict with the theory. The part played by pepsin is not clear. But my own investigations suggest that the secretion of pepsin follows that of acid. As secretion of gastric juice is so dependent on psychological factors the interpretation of the reaction to a test meal is by no means free from fallacy. It is, however, generally agreed that the stomach in duodenal ulcer is hypertonic, hypermotile, and hypersecretory, and that the reverse is true in gastric ulcer—at all events in the chronic cases.

The link between these variations of secretion and motility in peptic ulceration would, it seems, be in the central nervous system: a theory that has experimental support. Cushing and others have shown that lesions in the hypothalamus are frequently associated with peptic ulceration, and it may be noted here that in this region is the controlling centre of the sympathetic system. It is well known that the progress of a peptic ulcer is affected by the emotional state of the patient, and that this is closely coupled with sympathetic activity. In this connexion it is undoubted that vasomotor effects also must play an important part in the aetiology of peptic ulceration.

It looks as if the riddle of peptic ulceration will ultimately be solved by reference to the autonomic control of the stomach and duodenum; and as the final transmission of nervous impulses is through a chemical intermediary, hormonal and chemical factors will come into the aetiological picture. Until these various problems have been solved and a rational medical regime made possible many cases of peptic ulceration will still be best treated by surgical measures.

Mortality of Partial Gastrectomy

It might be thought that the mortality rate of an operation would be the most definite and easily arrived at of all the statistics connected with its performance. A study of the published figures, however, soon reveals that it is

almost impossible to establish what may be considered a fair average general rate. The following list, for instance, indicates that the most careful scrutiny is needed before a mortality rate can be accepted.

Reporter	Cases	Mortality Percentage
Moynihan	164 ..	1.6
Garnett Wright	62 ..	4
Morley (Polya)	47 ..	6
Bastianelli	137 ..	1.5
Schwartz	210 ..	18
von Haberer (Billroth II)	134 ..	11
Finsterer	175 ..	4
De Takats	226 ..	5.4
St. Bart's { Ulcer	207 ..	16.9
{ Carcinoma	67 ..	25.5
		18.6

In the items in this list, where the total number of cases is less than one hundred, an error due to the small numbers may have crept in, for it is within my experience that as many as sixty consecutive cases may be performed with but two deaths, but that when the number expanded to a hundred the mortality figure approached the general average of a large series. For this reason the smaller numbers can be ignored. With numbers above a hundred, however, this error gets considerably smaller, and it will be conceded that when a surgeon has performed over a hundred operations of this type he can no longer be accounted a novice, so that the figures are not subject to the criticism that the mortality might be considerably lowered with further experience. Even so we find in this series the utmost discrepancy. For instance, Schwarz with an experience of 210 cases gives a mortality of 18 per cent., whereas Moynihan with 164 cases has a mortality of but 1.6 per cent. Now it is impossible to believe that the skill of two surgeons of very big experience in the operation can be as different as these figures would lead us to think, and it immediately becomes clear that we must look for some other explanation. Either the mortality rate is a selected one from which certain cases are excluded—and in this regard it is of interest to note that the term "primary mortality" has unfortunately crept into some statistics—or the type of case chosen for operation is very different in the two clinics. To exclude from the operating list cases which look to be difficult and are bad operative risks may be regarded as good surgical judgement, but unless we have complete knowledge of how the refused cases fared without operation we are not justified in lauding a low mortality dependent upon such exclusion. So we are left in doubt as to the real mortality, and this quandary will remain until all surgeons agree to publish a complete mortality list without any equivocation or the introduction of such qualifying terms as "primary mortality." For these reasons, in dealing with the present series, I give first of all the total mortality from all causes whatsoever up to a period of three months after the operation.

In this way certain conditions only remotely connected with the operation have been included; indeed, the number of deaths due to intercurrent disease, such as pulmonary tuberculosis and uraemia, gives a percentage actually higher than the lowest figure in the above list for the deaths from all causes. It is this in particular which has made me suspicious of accepting these figures without qualification, for it must surely fall equally to the lot of every surgeon, experienced and inexperienced, to have such sequelae after an extensive abdominal operation, often of necessity performed upon patients in poor general condition.

The total number of deaths in this series reckoned in this way is as follows:

	No. of Cases	No. of Deaths	Deaths per cent.
Ulcer cases	242	23	9.5
Anastomotic (jejunal) ulcers	27	4	14.8
Carcinoma	51	7	14.0
Total.. ..	320	34	10.6

There was no immediate mortality—that is, within twenty-four hours—in this series.

When the ulcer cases were further subdivided into their separate groups an interesting result was obtained. The mortality rates then were: gastric ulcer, 11.1 per cent.; duodenal ulcer, 11.4 per cent.; pyloric ulcer, 5.3 per cent. This considerable difference in the rates was unexpected and obviously needs explanation. The gastric and duodenal cases include the very difficult ones where the ulcer is close to the cardiac orifice or extends from the duodenum into the pancreas or liver. These are the cases which technically tax the surgeon's abilities to the maximum, and it is only to be expected that the mortality would be above the average. The ulcers in the vicinity of the pylorus, on the other hand, constitute the easier cases, usually quickly performed without difficulty. As a corollary it is obvious that the surgeon who so chooses his case as to include a large proportion of these pyloric ulcers will show a lower mortality than one whose choice is made on a wider basis.

Causes of Death

The causes of mortality are always worthy of study, for only in this way can technique be improved. Payne (1936) has recently published the results of the post-mortem findings at St. Bartholomew's Hospital. He found that the commonest causes of death were peritonitis and pneumonia (thirty-two and fifty-one cases), while shock and infection around the duodenal stump accounted for a further nine deaths.

In the present series the list is as follows:

Chest complications, including embolism but excluding tuberculosis	12
Pulmonary tuberculosis	2
Haemorrhage, internal and intraperitoneal.. ..	4
Leakage and peritonitis	6
Thyrototoxicosis	1
Uraemia	2
Influenza.. ..	1
Delayed shock	1
Rupture and resuture of wound	1
Intussusception, anastomosis into jejunum.. ..	1
Damage to mid-colic artery	1
Embolism from haemorrhoidal and internal iliac veins	2
	34

It will be seen that in five cases death was due to the lighting up of intercurrent disease (tuberculosis, uraemia, and thyrototoxicosis), while in three others (influenza and thrombosis of haemorrhoidal veins following enemata) it was only very indirectly connected with the operation. If these be excluded twenty-six operative deaths remain (8.1 per cent. for all the cases, or 7 per cent. for the ulcer cases. When the patient is otherwise healthy, therefore, this figure may be taken as a fair representation of the risk. If the surgeon chooses his cases to exclude the very high ulcers and the complicated duodenal ulcers this mortality may be halved, but it should not be overlooked

that the need for radical treatment is often greatest in the cases which would thus be excluded.

As in Payne's series the greatest risk is of pulmonary complications, with leakage and peritonitis coming second. The former are due more to the operative manipulations than to the anaesthetic used, and so it is not surprising to find that, although almost every known type of anaesthesia has been tried, there has been little variation in the mortality.

Results

The results in the ulcer cases must be considered to be very satisfactory; 198 cases have been followed for two years upwards, and of these only fifteen are unsatisfactory. A further investigation of the unsatisfactory cases showed that in over 50 per cent. (eight cases) a second condition was present to account for the symptoms; thus four cases had cholecystitis and two had colonic spasm. In the remainder the result is unsatisfactory on account of persistence of symptoms. Four were thought to have jejunal ulceration. In two of these exploration was undertaken; one revealed a small ulcer on the lesser curve proximal to the anastomosis and close to the cardia, the other had no abnormality of any sort. Three definite cases of jejunal (anastomotic) ulceration were operated upon elsewhere, one having perforated, and they are included in these results.

A further analysis indicates that on the whole the more severe the lesion the better the result. This is not to be explained on the psychological basis that the patient who has suffered intensely is inclined to exaggerate the quality of the relief afforded him, for in most instances there has been absolutely no pain or discomfort after the operation. It also appears that the percentage of unsatisfactory results is larger in the duodenal cases than in the gastric ulcers. Since, however, the majority of duodenal cases give satisfactory results, I believe the explanation of both this and the previous anomaly to be that a certain number of misdiagnosed cases are included, particularly cases where a small duodenal ulcer (probably completely inactive) is found at the operation, but the patient's symptoms are really due to other causes. With gastric ulcers, for obvious reasons, this error is less likely to arise. The inclusion of but a small number of such misdiagnosed cases in a series of this nature is sufficient to account for the less satisfactory results in the duodenal cases and for the better results in the larger and more obvious lesions.

A small group, otherwise satisfactory, complain of a transient feeling of biliousness before breakfast or of faintness after a heavy meal. These cases have been investigated without any physical abnormality being discovered. I cannot help thinking that such symptoms may be due to involvement of the gastric branches of the vagus in the stomach scar. But it must not be overlooked that an extensive operation often has a bad psychological effect. Some patients remain excessively apprehensive in the epigastric region for long periods, even permanently.

Effect on the Blood

The functions of the stomach as a haemopoietic agent are now well understood, and it might be expected in consequence that an anaemia, even a pernicious anaemia, would follow gastrectomy. In fact, for reasons that are not yet clear, there is very little change in the blood count. In this series a large number of post-operative blood counts have been undertaken, but there is no record of any case of pernicious anaemia as yet. Since twenty-seven of the cases are of ten to fifteen years' duration it might be expected that any reserves or store of haemopoietic

substance would long since have been used up, if the pyloric end of the stomach is their only source. These are matters of medical interest; it is sufficient for the surgeon to know that experience shows that the dire results prognosticated ten years ago do not follow the operation. A mild microcytic anaemia does follow in some cases, but it is rarely severe enough to attract attention. An average of a large number of counts gave the following: red cells, 5,190,000; white cells, 9,390; haemoglobin, 95 per cent.; colour index, 0.88.

The Test Meal

The effect of the operation upon the test meal has been intensively studied. At the outset it must be realized that the performance of a test meal upon the post-gastrectomy case is associated with certain technical difficulties which render the results suspect. In this investigation every care was taken to ensure that the specimens were really obtained from the stomach stump and not from the intestine beyond.

Where a large Polya anastomosis has been performed there is almost always complete achlorhydria. With a restricted orifice there is in some cases a small amount of acid (15 degrees to 20 degrees) present in the one-hour specimen, but the general reduction of acidity is profound. Working on these cases Adler (1930) showed that even the completely achlorhydric cases retained the ability to respond to histamine stimulation, the test meal often showing over 20 degrees of acidity as a result of the injection. The same cases tested after a year or two had, however, lost the ability to respond. It was supposed that this might be attributed to a disuse suppression of the hormonal mechanism. Extracts prepared from the portion of stomach resected had no obvious effect.

Barium Meal

The radiographic results of the various types of gastrectomy were discussed by Shanks (1934) at the Bournemouth meeting of the British Medical Association. I cannot do better than quote from his paper:

"Polya; Lake's Modification. This modification, judging by the radiographic appearance, controls the efflux of the gastric contents better than any other of the Polya type. In addition to preventing 'dumping' into the jejunum it renders reflux into the afferent loop very improbable. The gastric stump fills reasonably well in the erect position, and the stoma is clearly seen at the lower pole. The right border of the stump is formed by the remaining portion of the lesser curve and the sutured end of the stump above the stoma. This largely loses its initial angularity, and becomes more or less straightened out. At the junction of the two there is apt to remain a dimple, which must not be mistaken for a recurrent lesser curve ulcer."

Results in Carcinoma Cases

The most important conclusion reached in this group is that there appears to be no absolute relation between the size of the growth and the period of freedom from recurrence, provided that there is no widespread metastasis at the time of operation. In this series two cases of massive carcinoma, several inches in extent, are known to be free from recurrence for seven and nine years respectively, while another, in a young man, did not recur until six years had elapsed. The average duration of life after the performance of the operation has, however, been but two and a quarter years. The freedom from symptoms to within a short time before death has been gratifying, and makes it advisable to continue with the operation even when the presence of secondaries beyond the possibilities of removal is discovered.

Operation

It is not intended here to enter into a technical description of the various operative details, but a brief account of the operation I now perform is necessary. This has been evolved slowly over a period of years, and, although it gives a result which is not unlike that of the Finsterer operation, it was devised entirely independently, each separate modification being introduced in an attempt to avoid some observed defect or fallacy in the cases previously dealt with.

The anaesthetic is a high spinal percaine given by a modification of the Howard Jones method, which enables very small doses to be used. The majority of cases have no other anaesthetic, but gas-and-oxygen is not denied to those who are psychologically unfitted to remain conscious. In an early stage a local injection of percaine is given around the oesophageal orifice of the diaphragm to diminish the nauseating sensation produced by traction upon the vagus. The proximal line of division passes very obliquely across the stomach from as high up the lesser curve as is technically possible, to a point on the greater curve at the junction of the epiploic arteries. In the average case this means that about two-thirds of the stomach is removed. The distal section is placed across the duodenum about an inch beyond the pylorus, unless the presence of a large ulcer here makes a more distal division necessary. In a few cases a colossal ulcer here renders section of the duodenum impossible, and then the stomach may be cut across proximal to the pylorus, a modification advocated as a routine by Ogilvie. This modification is not to be recommended, however, for any other than the most difficult cases. Similarly the proximal line of section may, under exceptional circumstances, leave a very high lesser-curve ulcer and yet a good result may be obtained, but this is also a device to be adopted only in the face of great technical difficulties.

The anastomosis is a retrocolic one, the first coil of jejunum being passed through an aperture in the mesocolon, which is usually to the left of the midcolic artery. The proximal end of the coil is attached to the lesser curve so that the bowel descends across the cut end of the stomach. The stoma now made in the bowel is equal in length to but half, or less, of the width of the stomach and is situated at the lower end of the anastomosis. Suturing is continuous, but is performed in such a manner as to close the upper portion of the stomach aperture and to fix the uncut portion of the jejunal loop over the suture line. Extra sutures are placed at the lesser curve as a precautionary measure and to attach the anastomosis to the aperture in the mesocolon.

A small drain may be used in cases where there is much oozing or where penetration of the pancreas or liver by the ulcer has rendered cauterization of these organs necessary. Careful after-treatment is essential, and no operation of this type should be undertaken without preliminary transfusion if the haemoglobin percentage is under 60. With spinal anaesthesia shock is slight and patients usually leave the table with an extremely good pulse. The operation may take anything from thirty-five to seventy-five minutes, but while no time should be wasted it is a mistake to scamp any part of the operation for the sake of saving a few minutes.

Indications

The indications for the performance of a partial gastrectomy may be absolute or relative. Carcinoma in the absence of widespread secondaries falls into the first

group, but this should also include cases of gross gastric ulceration. All other gastric ulcers which have not rapidly yielded to medical measures, and where the technical difficulties are not insuperable, should in my opinion be given the choice of a gastrectomy. Established duodenal ulcers without obstruction and with a high acid curve also form an indication, but those with pyloric obstruction and a low curve do so well with a gastro-enterostomy that it would be a mistake to subject them to the more risky operation. For anastomotic ulcers following gastro-enterostomy a gastrectomy is the only treatment likely to give permanent relief: some of the most gratifying results in this series come into this group.

Good surgical judgement, however, demands that many other factors connected with the patient's general condition be taken into consideration before the question of operation is finally decided.

Summary

1. Three hundred and twenty cases in which the operation of partial gastrectomy has been performed for gastric, duodenal, and anastomotic ulcers, and carcinoma are reviewed.

2. The after-history of the cases has been studied for periods up to fifteen years after operation.

3. Some aetiological ideas arising from the experiences of the cases are discussed.

4. The gross mortality from all causes was: ulcer cases, 9.5 per cent.; anastomotic ulcers, 14.8 per cent.; carcinoma, 14 per cent.

5. If an ulcer is situated in the pyloric region the mortality of the operation is but 5.3 per cent.

6. The commonest causes of post-operative death are lung complications and peritonitis.

7. The incidence of jejunal ulceration after partial gastrectomy is less than 2 per cent.

8. No cases of post-operative pernicious anaemia are recorded, but a microcytic anaemia of mild degree is occasionally seen.

9. The general permanent results in the ulcer cases are probably better than those obtained by any other method of treatment.

10. The average duration of life in the carcinoma cases after operation was two and a quarter years, but some patients with extensive growths lived for as long as seven and nine years.

11. The effects of the operation upon the test meal and the barium meal are described.

12. A brief account of the type of operation performed is given.

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