

MEDICAL ASPECTS OF PARTIAL GASTRECTOMY:

A REVIEW OF SEVENTY-FIVE CASES.

A THESIS

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MEDICAL ASPECTS OF PARTIAL GASTRECTOMYA REVIEW OF SEVENTY-FIVE CASESI N T R O D U C T I O NTHE PROBLEM

The late results of partial gastrectomy for peptic ulcer have been of particular interest to me during the last four or five years. During this period one noted that many cases did not progress post-operatively as would have been desired. In a number of cases it was impossible to find any single organic lesion on which to base this failure to progress satisfactorily. For this reason, and by virtue of the fact that partial gastrectomy has for the last thirty years been the operation of choice for peptic ulceration on the continent, for the last twenty years in the United States, and more recently in this country, the annual number of patients subjected to this form of therapy is very high. Therefore, it is pertinent to follow up these cases in order that one may ascertain the late results, for it is only the late results of any form of therapy which is the true criterion of the success or failure of that particular form of therapy.

The annual literature on this subject is voluminous, containing many articles with reviews of between forty and five hundred cases. Many of these articles are excellent and are the results of well and carefully controlled observations. Others of a less worthy character are the reports of a series of questionnaires sent to patients. This,

we feel, is an unsatisfactory means by which to obtain statistics for publication. Also a considerable proportion of these articles deal with some single complication or late result of this operation, e.g. the incidence of anaemia or stomal ulcer, and relatively few of the articles contain a complete review of the patient's well-being, mental, physical and bio-chemical. It is remarkable that the results of partial gastrectomy for peptic ulceration, which should be of interest to physician and surgeon, have come almost entirely from the former. It is for the above reason that we undertook this follow-up of seventy-five cases of peptic ulceration of the stomach, duodenum and jejunum with an open mind determined that the finding should be unbiased by any previous prejudices for or against this form of therapy.

THE MATERIAL

The patients on whom this follow-up was carried out were unselected inasmuch as they were found by examining the case records of half a dozen surgeons of the Royal Infirmary, Edinburgh. The selection of cases was carried out as follows: The operation book of the various surgeons was consulted and the names of the patients, subjected to partial gastrectomy for peptic ulcer, were obtained. The doctors attending the patients who had not died while in hospital were written to. The proposed follow-up of their patients was explained and permission to have these patients admitted for
/ follow

follow-up examination sought. Such permission having been obtained the patients were then written to. The co-operation of the general practitioners, and of the patients concerned was, on the whole, beyond reproach especially when one considers that the majority of these patients were working men and bread-winners for the family. Such being the case the admission to hospital meant the loss of three to four days wages, the visiting of their own doctor for certificates to their employers which enabled them to leave their work and the fact that swallowing a Ryle's tube is not a pleasant pastime especially when, as in most of these patients' cases, they had been subjected to it previously. In practically all cases, apart from a few who had died since leaving hospital, the patients were traced. Some five to ten per cent had left the district and, although we communicated with them by letter, they are not included in the follow-up series. In a number of these cases the patients volunteered that during their next vacation, they would be willing to come in for the follow-up test. However, this was not deemed desirable as it would have meant travelling several hundred miles under present-day conditions to say nothing of the expense and the fact that they would spend a part, at least, of their vacation in a hospital ward.

A small number of cases in this series were investigated less than a year after the operation. On the whole, these cases have come to us because

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they were failures and were reporting back to see whether or not anything could be done for them.

THE FACILITIES

The follow-up examinations in this series were carried out in Ward 21 at the Royal Infirmary, Edinburgh, under the charge of Professor Dunlop. Apart from the bio-chemical assays of blood chloride CO_2 combining power, plasma proteins, ascorbic acid and calcium the investigations were entirely carried out by the author. The co-operation of the X-Ray Department was most useful in the investigation of the gastric emptying time of these cases. In addition, with the help of the facilities of the Medical Out-Patient Department, we obtained the weights of two hundred consecutive admissions and were in this way able to compare the present-day weights of a series of outpatients with those on whom partial gastrectomy had been performed. With the aid of the Dietetic Out-Patient Department we were able to obtain an accurate pre-operative and post-operative account of the patients, including the precise diet which they had followed before and after the operation, and a similar account of the progress of their weight. This last observation has been invaluable as a criterion of progress following partial gastrectomy.

THE EXAMINATION

The patients were usually admitted in the evening, had a history taken and underwent a complete physical examination. On the morning of the first hospital day a test meal was carried

cut using the ordinary gruel as a stimulant. That afternoon the blood counts including Hb, R.B.C. C.I., P.C.V., M.C.V., M.C.H.C., and W.B.C., were determined. On the morning of the second day oxalated and non-oxalated venous blood was withdrawn and sent for the various bio-chemical investigations. The patient was then subjected to a second test meal similar to the first but histamine 1.0 mgm. subcutaneously was given after the fasting specimen had been withdrawn, after which the investigation was carried out as for the first day test meal. On the morning of the third day a glucose tolerance test was performed at the end of which time, unless further investigations were desired, the patient was discharged. Were it deemed advisable to pursue investigations further the patient was detained until such investigations were completed. These included second glucose tolerance tests, fat balances, nitrogen balances, barium meals and barium enemas. The period of hospitalisation was, then, one of rigorous investigation.

As mentioned previously these cases were not the end results of the surgery of any one operator but rather of six surgeons all using approximately the same technique, but each having his own slight technical peculiarities which may, or may not, have influenced the end results. In the great majority of cases the operation performed was a Polya, sometimes modified in accordance with the Hoffmeister technique.

We feel, therefore, because of the number of surgeons who carried out these operations that the results here portrayed are a fair index of a cross section of the surgical results of partial gastrectomy for peptic ulceration in the Royal Infirmary, Edinburgh.

P A R T I
C H A P T E R I

HISTORY OF PEPTIC ULCERATION

Peptic ulceration of the stomach and duodenum might almost be called a recent disease when one compares it with such diseases as tuberculosis and malaria - both of which were lucidly described by the Hippocrates in 400 B.C. Had peptic ulceration been a clinical entity of any magnitude at that time it almost certainly would not have escaped description by the "Father of Medicine".

The first reference to this scourge of modern mankind was that of Marcellus Donatus in 1586 who described a pre-pyloric ulcer causing obstruction - that was in the sixteenth century. During the next two centuries reference to, and interest in, this condition was increasing. Most of the reports of that period were concerned with peptic ulceration as a cause of haemorrhage or perforation and there was only scanty mention of its pathology.

At this time, gastric ulcer would appear to have been a much more frequent occurrence than duodenal ulcer. The first clear description of the former being given by Mathew Baillie, an outstanding pathologist as well as being a physician of the first magnitude - holding the post of Honorary Physician to St. George's Hospital and later President of the Royal College of Physicians, who, in 1793 published his observations in an article entitled "Morbid Anatomy of Some of the

Most Important Parts of the Human Body". He described the naked eye appearance of such lesions as follows: "Opportunities occasionally offer themselves of observing ulcers of the stomach. These sometimes resemble common ulcers in any other part of the body but frequently they have a peculiar appearance. Many of them are scarcely surrounded by any inflammation, have no irregular eroded edges as others have generally, and are not attended with any particular diseased alteration in the structure of the stomach in the neighbourhood. They appear very much as if, some little time before, a part had been cut out from the stomach with a knife and the edges had been healed so as to present a uniformly smooth boundary around the evacuation which had been made. These ulcers sometimes destroy a portion of all the coats forming a hole in the stomach" - what we of to-day would term a typical "punch-out" ulcer.

The same observer - Mathew Baillie - in keeping with the opinion of the times demonstrated in 1799 a drawing illustrating a case of multiple gastric ulcers and a duodenal ulcer - the latter apparently being of little interest. However, during the period there are occasional references to duodenal ulceration - generally because of some complication of which they were the cause. Perforation of a duodenal ulcer was referred to by Dr. Muralto in 1688, Sir George Baker in 1772 and Travers in 1817.

The chronic nature of gastric ulcers was

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also alluded to by Baillie in the words "I have reason to believe that ulcers of the stomach are often slow in their progress. They are attended with pain or an uneasy feeling in the stomach" - and to the fact that they may cause stenosis - "what is swallowed is frequently rejected by vomiting. This state continues for a considerable length of time and is very little relieved by medicine which may serve as some ground of distinction between this complaint and a temporary deranged action of the stomach".

With the closing of the eighteenth century the secrets of gastric physiology were first probed by Lazzaro Spallanzani of Pavia. Spallanzani is one of the great names in gastric physiology. In his experiments on digestion he swallowed linen bags containing food, perforated wooden tubes, and was enough of a scientific martyr to obtain gastric juice by making himself vomit on an empty stomach. He supplemented his self-experimentation by experiments on a surprising variety of animals. Spallanzani confirmed and extended Reamur's work by pouring gastric juice drop by drop on meat and bread, demonstrating that it dissolved foods in a test tube as readily as in the body. Some beautiful theories died when the stomach ceased to be regarded as a churning mill, mechanically grinding food by muscular force and digestion was seen to be neither concoction, trituration, putrefaction, fermentation nor macreation. The eighteenth century learned through Reamur,

/ Spallanzani

Spallanzani and Eduardus Stevens of Edinburgh that digestion is the result of the solvent power of the juice manufactured by the stomach. John Hunter in London, (1728-1793) who also was working on the functions of the stomach was indignant on hearing of Spallanzani's work, complaining that the former was not an anatomist and that "like all mere experiment-makers he is not satisfied even with those which are clear and decisive, but multiplies them unnecessarily".

The story of the American Army Surgeon, Beaumont, who, while stationed at an outpost in Michigan in 1822 was called upon to attend Alexis St. Martin, a French Canadian voyageur, who had received an abdominal wound resulting in a gastric fistula, has become a classic in the history of medicine. Beaumont's experiments on St. Martin were commenced in 1825 and completed in 1833 after they had travelled many thousands of miles to complete the studies. Beaumont noted the normal appearance of the gastric mucosa, that gastric juice was secreted only in the presence of food and that irritation of the mucosa produced redness. His studies on the relative digestability of various foodstuffs mark the foundation of modern dietetics. He also noted that hydrochloric acid alone would not digest meat and that pepsin of the gastric juice was necessary, calling it "Mureatic Acid".

During the nineteenth century the clinical features and morbid anatomy of peptic ulceration / gained

gained a more sure footing by the stimulating work of Cruveilhier in France and Abercrombie in Edinburgh. Because of his description of gastric ulcer - which vies with Bright's description of nephritis as a masterpiece of clinical observation and pathological orientation, gastric ulcer became known in France as "La Malade de Cruveilhier".

Jean Cruveilhier, the son of an Army Surgeon, on witnessing his first autopsy became so filled with distaste for medicine that he fled to the Seminary Sulpice of St. Sulpice with the hope of realising his old desire to become a priest. His domineering father hastened to Paris and compelled his disobedient son to re-enter medicine. Cruveilhier, in his time, held in succession three chairs - the Professorship of Surgery at Montpellier, Professor of Descriptive Anatomy at Paris and later the newly created chair of Pathological Anatomy in the same University.

In 1830 he published "Anatomie Pathologique du Corps Humain". In this vast work Cruveilhier describes and pictures several cases of gastric ulcer. In his masterly way he describes simple peptic ulceration of the stomach, its most frequent sites and clinical features. He then describes syphilitic ulceration of the stomach and later the macroscopic difference between simple gastric ulcer and gastric carcinoma. Speaking of simple gastric ulcer he wrote "The base of it does not show any of the characteristics of either a hard cancer or a soft cancer - one does not find the circumscribed

/hypertrophy

hypertrophy which practically always accompanies cancer and which may be taken so often for a cancerous degeneration itself". This reference to the base of the ulcer as the key area for the differentiation between simple and malignant ulceration of the stomach is of interest, inasmuch as it is in this area that the student of pathology to-day is taught to seek for the various changes which identify these two conditions.

In spite of the depth to which Cruveilhier probed the problem of gastric ulcer, he presumably failed either to observe any cases of duodenal ulcer or ignored this subject completely, for throughout this "Anatomie Pathologique du Corps Humain" he makes no reference to it.

During this period, however, an enlightened Scotsman, John Abercrombie of Edinburgh, was writing on the clinical features and treatment of duodenal ulcer. Noting the "food-pain" time relation he stated "The leading peculiarity of disease of the duodenum, so far as we are at present acquainted with it, seems to be that food is taken with relish and the first state of digestion is not impaired, but the pain begins when the food is passing out of the stomach, or two to four hours after a meal". Nor did the periods of freedom from symptoms so characteristic of this condition escape his notice. "We should not be deceived either by the pain having remarkable remissions and the patient enjoying long intervals of perfect health, or by remarkable attenuation of the

/symptoms

symptoms taking place under a careful regulation of diet".

His treatment of haematemesis was to serve as the universal basis of therapy until the advent of the Meulengracht diet and even to-day would be looked on by most physicians as a very reasonable dietary regime. "The food must be very small in quantity and of the mildest quality, consisting chiefly or entirely of farenaceous articles and milk, and it would appear to be of much consequence to guard against any degree of distention of the stomach, that can possibly be avoided even by the mildest articles".

In 1842, Curling reported a series of twelve cases in which acute duodenal ulceration had followed on severe burns. Factors other than burns which were considered of aetiological importance in peptic ulcer were preceding gastritis (Cruveilhier) and haemorrhagic erosions (Rokitansky 1849). Shortly thereafter, Virchow (1853) disciple of Rokitansky in Vienna advanced the theory that formation of ulcer was dependant on vascular disease. First efforts at the experimental development of ulcer were those of Lebert (1837) who was able to produce erosions of the gastric mucosa as a result of pyaemia produced by the injection of pus into the veins of animals.

Further steps towards the development of methods of analysis of the gastric content during this period consisted of Bush Pump attached to a catheter in the stomach and Arnott's stomach

syphon. However, the work of these men passed almost unheeded and it remained for Adolf Kussmaul 1867 to exploit the use of what was then known as the stomach pump. It is probable that this instrument was first used by Guillaume Dupuytren in 1810 to wash out the stomach following an attempted suicide. Kussmaul's first patient to be subjected to the stomach pump would appear to have been a case of duodenal ulcer with pylorospasm. A young woman who had suffered from stomach trouble for fourteen years was extremely emaciated and had marked enlargement of the stomach. He treated his patient by pumping out the stomach and irrigating it with Vichy water. The patient improved rapidly gaining more than twenty pounds and was completely cured. The fame of the stomach pump spread far and wide and was extensively used in the treatment of dilatation of the stomach. Kussmaul made no claim to be the inventor of the stomach pump and stated that he made its acquaintance through an article in the "American Journal of Medical Sciences".

Although Kussmaul popularised the stomach pump for the treatment of stenosing peptic ulcer, yet he ignored its diagnostic value. Wilhelm Leube in 1871 first realised the value of the stomach tube for aspiration of the gastric contents and their subsequent analysis. As Korn remarks "After Kussmaul in 1869 introduced the stomach tube into therapeutics it was the lasting achievement of Leube to have first employed the stomach tube for

diagnostic purposes".

Leube used a test breakfast of soup, beef-steak and a bun - the first two being very good secretagogues. Leube's work was continued by Van Den Vilden who could find no free acid in the presence of gastric carcinoma, and later by Ewald (1874) who with the collaboration of Boas introduced the gruel test meal which is still used.

With the closing two decades of the nineteenth century came the teaching of Cruveilhier and Abercrombie that peptic ulcer was curable; that dietary hygiene was of importance in both the treatment of ulcer and the prevention of its recurrence and lastly that milk should form the basis of the diet became the accepted form of medical therapy. Leube and Ziemssen (1888) stressed the importance of rest to the body generally and to the stomach in particular. Who first recommended the use of alkalis in the treatment of peptic ulcer is unknown, but bismuth was being extensively used in the 1880's.

At this time there came a new mode of therapy, surgery, aided greatly by two new discoveries. Firstly, the antiseptic surgical era introduced by Lister, and secondly, by the discovery in 1895 of X-Rays by Röntgen. The development of the surgical therapy of peptic ulcer will be discussed fully in Chapter III.

Probably the most far-reaching discovery of medical science in the last hundred years was William Conrad Röntgen's discovery. The wide

/ applicability

applicability was apparently not appreciated at first and the Journal of the American Medical Association wrote sceptically: "The surgeons of Vienna and Berlin believe that the Rontgen photograph is destined to render inestimable services to surgery. Half and hour is the shortest exposure possible and most require an hour. The electrical apparatus required is so expensive, \$ 100,00 and upward, that few surgeons can use it yet in their private practice".

The first attempt to visualize the stomach was apparently made by Hemmeter in 1896 by introducing a bag containing a solution of lead acetate and then taking X-Rays. Walter B. Cannon 1897 first employed free bismuth in an opaque meal in animals and later in the same year Rumpel published the first account of the application of bismuth to visualize the alimentary tract in man; an advance of the first magnitude in the diagnosis of peptic ulcer.

It is interesting to look back and see what the present century has contributed to aetiology, diagnosis and treatment of peptic ulceration.

AETIOLOGY

Although the cause is not yet established great advances have been made in this direction. In 1900 considerations of the cause were primitive. The anatomically vulnerable areas of the stomach and duodenum had been demonstrated by Virchow and Aschoff. The latter then postulated his theory of a mechanical origin by which the "magenstrasse"

more rigid than the rest of the stomach was injured by the trauma of food passing over it during gastric peristalsis.

The bacteriological basis of peptic ulcer was put forward by Rosenow in 1923 who, by injecting streptococci intravenously in rabbits was able to demonstrate haemorrhagic erosions and ulcers of the stomach, and concluded that the basic cause of peptic ulceration was the entry of streptococci into the blood stream from cryptic foci.

Two theories of aetiology to which much attention has been paid by clinicians in recent years have had to do with the constitutional and neurogenic features of this disease. In 1918 Bergmann brought forth his theory that derangement of the nervous system was the most significant aetiological factor. He believed that the dysfunction led to spasm of the muscularis mucosa and blood vessels. The vascular spasm resulted in decreased mucosal resistance and ulceration.

Harvey Cushing demonstrated that ulcers, of the stomach in particular, are frequently associated with and produced by lesions of the midbrain.

The fact that symptoms are worse during worry and times of anxiety has been demonstrated particularly during the last ten years. Especially by Tidy whose work during the air-raids in London has borne this out.

The patients' constitution as a factor was the basis of many papers by Hurst and Stewart. The hypersthenic gastric diathesis more prone to

develop duodenal ulcers and the hyposthenic more prone to develop gastric ulcers. These authors and Von Bergmann emphasised, as have many writers of the past few years, that peptic ulceration is merely a local manifestation of a constitutional disease.

The recognition that the gastric juice is a factor in peptic ulceration is an old one. Hurst and Stewart have emphasised its importance in man. While Ivy, Dragstedt, Mann, Lim, Babkin and others have demonstrated this in animals, Dragstedt in experimental work preparatory to supra-diaphragmatic vagal section, has shown in man the effects of worry, anger etc., on the flow of gastric juice. Wolf and Wolff by observing the gastric mucosa through a gastrostomy opening have observed the vascular changes of the mucosa brought about by changes in temperament.

DIAGNOSIS

Few noteworthy diagnostic advances apart from advances in rontgenology have taken place. Moynihan in the early part of the century stressed the important sequence of "pain-food-ease" as a diagnostic criterion of peptic ulcer.

In 1904 Reider published the results of his studies on the alimentary canal by bismuth and gruel. The next few years were devoted chiefly to advances in the positioning of patients for gastric and duodenal X-Rays. Holzknacht and Groedel then developed a method of fluoroscopic study of the upper alimentary tract. Handek in 1910 described the ulcer niche and Kastle, Reider

and Rosenthal advanced the work on the radiological appearance of the duodenal bulb in peptic ulcers. Since that time with the use of barium instead of bismuth and the improvements in technique and equipment, the "secondary" signs of ulceration have assumed a prominent place in diagnosis.

Gastroscopy first attempted by Kussmaul in 1879 by inducing a sword swallower to pass a 47 cm. metal tube into his stomach and through which, due to the absence of a light on the tip, Kussmaul was unable to visualize the stomach. The instrument went through numerous modifications by Rosenheim, Kelling, Kuttner and Jackson, and proved of no real value until the introduction of the flexible gastroscope by Wolf and Schindler. As Eusterman stated in 1938 "Accumulating experience also attests the indispensability of competent gastroscopic examination in daily gastro-enterologic practice".

SURGERY

The advances during this century have not been dramatic but they have been progressive. Improvement in technique on the basic operations of Billroth and Wolfler and the new operation of supra-diaphragmatic vagal section of Dragstedt has brought new hope.

The success of gastric surgery is indebted in no little measure to what might be called the "adjuncts of surgery" which have advanced rapidly during the present era.

Surgery, as mentioned previously, will be

discussed

discussed in Chapter III - suffice it is to note at this point that the more accurate localisation of peptic ulcers by X-Rays have made the task of the surgeon easier. In addition, the advances in anaesthesia, spinal anaesthetics, cyclopropane and curare have reduced both the anaesthetic deaths and the post-operative complications.

Coupled with the advances in anaesthesia which allow more radical surgery must go the new antibiotics, sulphonamide (1936) and penicillin (1942) which by reducing the incidence of infection as a cause of post-operative mortality must also be included as aids to successful surgery. Protein hydrolysates, though their advent is recent and their clinical uses very limited, have found support from such gastric surgeons as Wangansteen and Elmen - chiefly in the pre-operative treatment of pyloric stenosis. The exhibition of protein hydrolysates in the pre-operative period of such cases, either by intravenous or oral administration, has been shown by the above authors to render the patient a much better operative risk.

MEDICINE

Medicine "per se" has contributed substantially to the advances in the therapy of peptic ulcer in the last forty-seven years. The basic principles of diet had already been laid down in 1830 by Cruveilhier and Abercrombie. In the early "twenties" Sippy of Chicago introduced his famous

/diet

diet by which the patient received practically nothing but milk - a modification of this regime was introduced into Britain by Hurst.

The time-honoured treatment of haematemesis by complete starvation suffered a severe setback in 1936 when Meulengracht of Copenhagen produced figures showing a mortality of 3 per cent when these patients were treated by liberal feeds of beefsteak and the like, while the blood they had vomited was still on their lips. Witts, by striking a compromise between the extremes of Meulengracht and the starvation diet, set out a basis of treatment which has been supported by most physicians in this country, although some still feel that the results of the starvation method are superior.

C H A P T E R I IEARLY ANIMAL EXPERIMENTATION
AND OBSERVATIONS ON PARTIAL GASTRECTOMY

Billroth may well be called the "Father" of gastric surgery, for it was he who in 1881 first performed a successful pylorotomy. Before this epoch-making operation was performed on the human body partial gastrectomy had been carried out on animals by previous investigators.

The first reference we have to these animal experiments is that of Merrim who, in 1810, resected a portion of a dog's stomach and succeeded in keeping it alive for twenty-seven days. In 1874 Gussenbauer and Winiwarter working in Billroth's laboratory set the basis of Billroth's initial No. 1 operation by performing the operation on dogs.

About the same time Klemensiewicz was performing similar animal experimentation but his mortality rate was extremely high, practically all the animals dying during the first week of the post-operative period. Heidinhein two years later using the aseptic technique brought forward by Lister was able to keep his animals alive for five months.

De Flippe in 1894 published two papers on the effects of partial gastrectomy on dogs. He found as did Ogata in 1883, that the absorption of foods was fairly complete except that undigested residue was passed by the bowel in considerable amount. He also noted that putrefaction in the bowel was

/ greater

greater than normal as was shown by the presence of indican bodies and an excess of ethereal sulphates in the urine which was found also to contain an excess of urobilin.

Carvallo and Pachon in 1895 published two articles on the effects of partial gastrectomy on cats. They observed that following this operation the animals were loathe to eat, but in contradistinction to the dog, they digested their foods more completely and very little undigested residue was passed by the bowel. Carrel, Mayer and Levine investigated the nitrogenous metabolism of gastrectomised dogs and came to the conclusion that there was no note-worthy difference from the normal. During the last thirty years innumerable investigators have carried out animal experimentations on the partially gastrectomised dog or cat. The leading workers in this field have been Wangensteen, Dragstedt, Ivy, Babkin and Lim, whose work will be referred to in the appropriate chapters relevant to the special ramifications of the subject with which they have dealt.

C H A P T E R I I IHISTORICAL SUMMARY OF PARTIAL GASTRECTOMY
AND GASTRO-ENTEROSTOMY

One cannot write on this history of partial gastrectomy in the treatment of chronic peptic ulcer without writing also on the history of gastro-enterostomy. The history of the surgical therapy of this condition is essentially the history of these two procedures, whose popularity varied from time to time, sometimes one sometimes the other being the intervention of choice. These changes of popularity were due to many factors, the reputation of the surgeon who recommended it, some new modification in technique and, by no means least, the mortality and late results.

Billroth of Vienna, while closing a gastric fistula in 1877 envisaged the operation of partial gastrectomy and, as mentioned, carried out animal experimentation in collaboration with Gussenbauer and Winiwarter to establish the value of this procedure prior to performing it on one of his patients. During this period of animal experimentation by Billroth and his colleagues, Pean, 1879, attempted a pylorotomy for a benign tumor. However, in spite of three blood transfusions the patient succumbed on the third post-operative day. A year later Rydygier attempted a pylorotomy and again the patient died during the first post-operative day.

In 1881 Billroth, his experimental studies now completed, decided to attempt his No. 1

/ operation

operation in man. The patient was suffering from a pre-pyloric carcinoma and Billroth performed the first successful pylorotomy in history on this patient. The result was so gratifying that one month later he performed the same operation which again was a triumph of surgery.

Later that year Wolfler working in Billroth's clinic attempted to repeat his Chief's performance in another case of gastric carcinoma. However, he found the growth had extended to the surrounding tissue, was fixed and irremovable and was about to close the abdomen, when his assistant Nicoladoni suggested a short circuit to the jejunum to circumvent the obstruction - Wolfler agreed. He brought a long loop of jejunum up in front of the colon and anastomosed it to the anterior wall of the stomach. This was the first gastro-enterostomy performed almost as an afterthought.

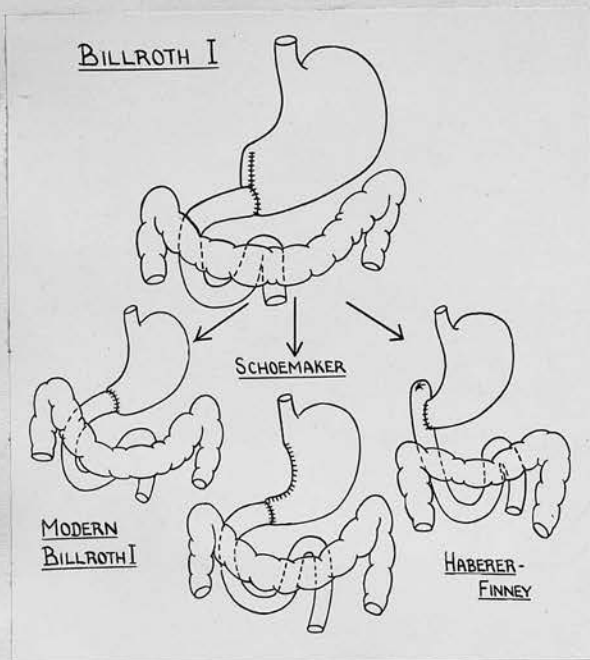
The year, 1881, was then an epoch making one for gastric surgery, for in that one year and from one clinic came the two operations which were to form the basis of the surgical treatment of gastric carcinoma and peptic ulceration of the stomach and duodenum, and which, in spite of the dramatic strides in therapeutics have stood the test of time and continue, apart from the recent supra-diaphragmatic vagal section for peptic ulcer, to remain unchallenged as the surgical procedure of choice in these two conditions to which so many millions of mankind are destined.

It was natural that, with these new weapons

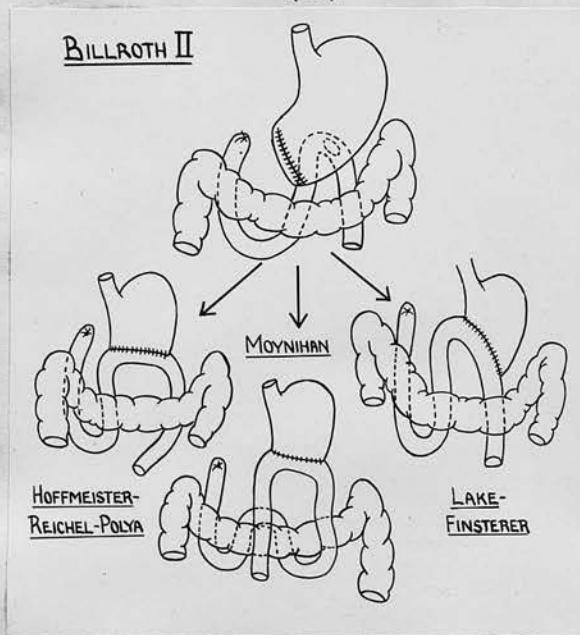
/pylorotomy

DIAGRAM I

(a)



(b)



Principal operations developed from

(a) Billroth No. 1

(b) Billroth No. 2.

pylorectomy and anterior gastro-enterostomy coming concomittantly into a virgin field of surgical therapeutics, the indications for each and the modifications in technique should undergo progressive and to some extent, radical changes.

The brilliant success of Billroth's first two pylorectomies was not sustained. Two years after its introduction the Billroth Clinic had performed some twenty-five No. 1 operations with the alarming mortality of 80 per cent. The lethal factor in this operation, as Billroth pointed out, was the tension on the suture line due to the difficulty in mobilising the duodenum. Consequently the anastomosis was prone to leak and lead to a fatal peritonitis.

In spite of this disadvantage, the operation in a modified form has been the choice of surgeons whose names are household words in gastric surgery, particularly those of Von Haberer and Shoemaker. The latter, by using a clamp which allows removal of a much larger portion of the lesser curvature, restores the stomach almost to its normal shape.

In 1883 - because of mortality of the No. 1 operation - Billroth brought forth his No. 2 operation. In this procedure the cut ends of both the duodenum and stomach are closed and the danger of leakage thus reduced. This operation, like the No. 1 has gone through various modifications by the surgeons employing it. These are shown in Diagram No. 1. Hoffmeister, 1888, by having the stoma in only the lower half of the gastro-

/ jejunal

jejunal suture line instead of along the entire line aimed at prolonging the time of gastric evacuation. The operation gradually became more radical until it assumed the proportions of a partial gastrectomy rather than a pylorotomy.

The most important modification is the Polya published in 1911, although the same operation had been thought out and performed by Sherren in 1910. This operation with the site of the anastomoses along the line of closure of the gastric remnant - rather than behind it as in the Billroth No. 2 - allows more of the stomach to be removed.

From the Polya have come other modifications of the Billroth No. 2. The Moynihan, Balfour and Finsterer to mention only a few.

Gastro-enterostomy has a similar history of modifications. Following its introduction in 1881 it was a short and logical step to employing this new operation for simple pyloric stenosis, and in 1884 Rydygier performed the first gastro-enterostomy for this condition. In 1893 Codivilla performed gastro-enterostomy for chronic duodenal ulcer without stenosis and in 1895 Doyen performed it for gastric ulcer, though the reason in these two cases for it might not seem obvious. It was supposed that pyloric spasm was responsible for the symptoms. In 1895 Hartmann performed gastro-enterostomy for haematemesis. The important modification of making the anastomosis on the position wall of the stomach and bringing the loop of jejunum behind the colon was devised by Von

Hacker in 1885. The popularity of this operation was illustrated by the fact that in 1900 Mayo Robson was able to collect the records of 1,978 cases on which gastro-enterostomy had been performed.

During this developmental period of partial gastrectomy and gastro-enterostomy other, less popular, operations were being devised. In 1886 the operation now known as pyloroplasty was first performed by Heineke and later by Mikulicz. The "unilateral pyloric inclusion" of Von Eiselberg was first devised and practised by him in 1895. The operation of simple local resection of a gastric ulcer was first successfully performed by Rydygier in 1881, and this became the standard method of treatment for lesser curvature ulcers with or without gastro-enterostomy.

Thus the technical possibilities of gastric surgery had been almost fully explored at the turn of the century. Of all these procedures none has been so frequently performed or so much a subject for controversy as gastro-enterostomy. With the stimulus to surgery resulting from the more accurate diagnosis possible with X-Rays of the stomach and the fact that the mortality was much lower than in partial gastrectomy - the only other therapeutically comparable operation - the popularity of gastro-enterostomy for the treatment of peptic ulceration was ever increasing, and on a statistical basis was performed many times over

for each partial gastrectomy. By 1915 it was being performed as a matter of routine in many parts of the world for all cases of chronic duodenal ulcer - and even for cases of dyspepsia in which no ulcer could be demonstrated. Moynihan declared "I am an ardent and sanguine advocate of this operation (gastro-enterostomy) and there is none in all surgery more completely satisfactory". Sherren likewise lauded this procedure with the words "gastro-enterostomy has done as much if not more good for the human race than any other surgical procedure". Honoured as their names in surgery are, Lord Moynihan and Sherren would find very few to support their feelings to-day.

The first disillusionment regarding gastro-enterostomy came with the appearance of a new pathological lesion - the stomal ulcer. The first case described was that of Baum in 1889 - it raised little comment and was looked on as a curiosity. During the ensuing two decades the incidence of stomal ulcer was ever increasing in proportion to the number of gastro-enterostomies performed so that in 1909 Paterson reported 52 definite cases following this operation. The reaction of Moynihan was to regard stomal ulcer as due to errors of technique and to look on 2 per cent as a generous estimate of its incidence. In spite of Moynihan's belief that faulty technique was the basis of stomal ulcer, competent surgeons reported a growing incidence of this complication; Eusterman in 1920 reported 83 cases

at the Mayo Clinic. Balfour, Walton, Luff and others estimated its frequency at 4 per cent, while Hurst and Stewart believed it to be "a dangerous and frequent sequel of gastro-enterostomy" and placed its incidence at 50 per cent. A.A. Berg at the Mount Sinai Hospital in New York reported its incidence to be 35 per cent; at the same time stating that he had never seen this condition as a complication of partial gastrectomy.

Apart from the risk of stomal ulceration the positive benefits of gastro-enterostomy also seemed doubtful and Cuthbert Wallace declared "I believe that there is only one thing that gastro-enterostomy can cure and that is pyloric obstruction". These disquietening facts had two results. Firstly, more stress was laid on the indications for this operation than on the actual technique, and secondly, many surgeons decided to perform the more radical operation of partial gastrectomy in spite of its rather higher mortality. This trend towards the increased use of partial gastrectomy took place on the continent rather earlier than in the United States and Great Britain. Finsterer, writing in 1926, stated that since 1919 he had employed partial gastrectomy in practically all cases which were not complicated by perforation - during that period he had performed partial gastrectomy (for gastric or for duodenal ulcer) 593 times and gastro-enterostomy only 5 times. In the United States Berg was the chief exponent of partial gastrectomy when in 1914

in his clinic at the Mount Sinai Hospital it was made the operation of choice for gastric ulcers, and in 1922 for duodenal ulcers.

During the early "twenties" the operation was gradually adopted by the leading of the great American Clinics. The surgeons of Great Britain were rather more hesitant in accepting this form of surgical therapy, probably due in no little measure to Lord Moynihan's implicit faith in gastro-enterostomy and the remarkable success that resulted from his use of this procedure. In 1928 he stated "Gastrectomy for duodenal ulcer is neither safe nor simple and does not give better end results than gastro-enterostomy. The worst of gastro-enterostomy is known and the best is unsurpassable. We have yet to learn the worst of gastrectomy and what we know of it is unfavourable enough".

The early reports on the results of this operation published in Britain are those of G.G. Taylor et al, and Morley and Roberts published in 1928.

The true merits of these various operations have not yet been clarified and after sixty years the rightful place of gastro-enterostomy is still a matter of some doubt and confusion. Of recent years some surgeons have been disappointed with the end results of partial gastrectomy and feel as did Wilkie, Walton, Balfour and Devine that "Gastro-enterostomy must still remain the basis of average gastric surgery" (Devine).

It may be that in the light of the work published during the last two years by Dragstedt, Wangansteen and Moore and others concerning the results of supra-diaphragmatic vagal section for gastric, duodenal, and stomal ulcer, that the controversy of partial gastrectomy versus gastro-enterostomy may be nearing an end. However, the results of this latest attack on peptic ulceration have not, as yet, stood the test of time. It is pertinent, therefore, that we should review the results of partial gastrectomy, an operation which has been known for sixty years, and extensively used for thirty years, before disregarding it completely in favour of a new procedure, the results of which, though they have not been surpassed over a short follow-up period, may have some deleterious effect on bodily economy which only time will bring to the surface as it has done with stomal ulcers, sometimes thirty years after gastro-enterostomy.

C H A P T E R I VHISTORY OF POST GASTRECTOMY INVESTIGATIONS

The first reports to be published on the effect of gastric resection on the economy of the body were those of Langenbuch in 1894 who, from his studies on two women patients subjected to partial gastrectomy, concluded that it caused no serious detriment to the patients.

The next year, 1895, Schuchnardt described a case in which the patient had a 5/6 gastric resection. This investigator noted that for the first few months following the operation the patient was able to eat small meals only because of a feeling of post prandial epigastric distension. This incapacity, however, gradually improved with time. Schuchnardt also made the observation that the upper part of jejunum of this patient had become dilated following the operation. At post mortem, two and a half years after the operation, the capacity of the upper jejunum was found to be 500 c.c.

Wroblewski, 1897, who carried out a follow-up on a case of total gastrectomy performed a few months earlier by Sclatter reported that the patient was in good general health. The gastric analysis showed free hydrochloric acid in small amounts and the urine was normal except for an abnormally large amount of indican. The fact that he then goes on to describe the vomitus in some detail would seem to indicate that the patient was probably not in as good health as he stated earlier. This was

/followed

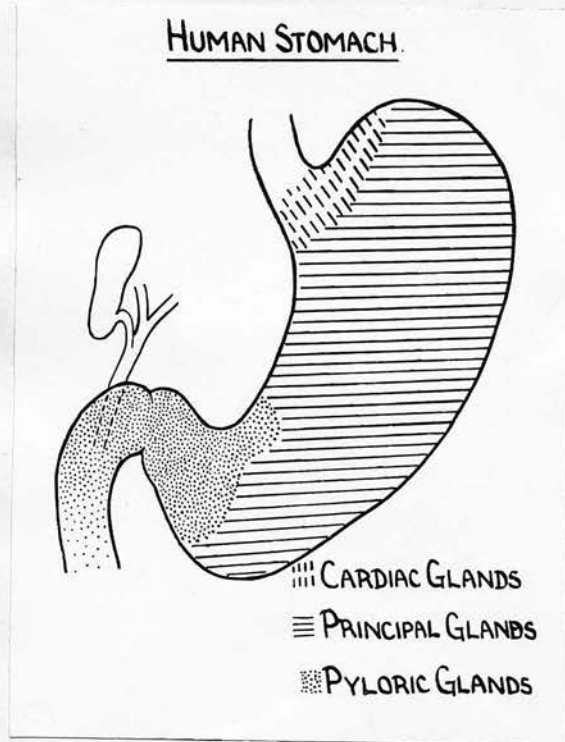
followed a few months later by a report from Hoffman of a patient three months after partial gastrectomy.

Of the earlier articles on this subject that of Deganello in Italy, is by far the most scientific. Deganello's report is based on his findings in a woman of 48 who had been operated on for a gastric carcinoma a few months previously by Triconi. The author states that the patient's digestion and absorption were comparable with the normal. That for a few months after the operation large amounts of ethereal sulphates, due to intestinal putrefaction, were passed in the urine and that examination of the stools showed the constant presence of undigested meat fibres. Three months after the operation the patient's blood showed a microcytic hypochromic anaemia, Hb. 65 per cent, R.B.C. 3,670,000. Deganello was the first to describe this complication of partial gastrectomy. He concludes "In this case a wonderful compensatory process is built up, in virtue of which the organism gradually adapts itself to such greatly altered conditions of life".

Sir Berekly Moynihan in 1907 described a case of gastrectomy performed for a scirrhus carcinoma of the stomach three years and eight months previous. At autopsy no metastases were found and it was concluded that the patient had died of anaemia although, unfortunately no blood counts were done. That was forty years ago, since then with the generalised acceptance of partial gastrectomy in

the therapy of peptic ulceration, the annual literature on the results of this operation are legend, and those of note will be alluded to in the special sections of this Thesis. However, the names of Schuchardt, Sclatter, Wroblewski, Moynihan and especially Deganello will always be remembered for their pioneer work in this great field of clinical research.

D I A G R A M I I



Distribution of the three main types of secretory glands in the human stomach - "Principal", "Fundal" and "Body Glands" - are synonymous.

P A R T I I
C H A P T E R V

PHYSIOLOGICAL BASIS FOR
PARTIAL GASTRECTOMY

Before discussing the results of partial gastrectomy it is logical to review the physiological principles on which this procedure is based. Any operation in which the removal of an ulcer of 1 cm. in diameter demands the sacrifice of part of the duodenum and two-thirds of the stomach demands a rational basis. Dragstedt (1947) has shown that in bodily economy the secretion of gastric juice has a high priority. This investigator by continual drainage of a dog's isolated stomach found that the stomach continued, in spite of the resultant alkalosis, to secrete acid at full concentration and volume. This secretion continued unabated until the animal succumbed from the effects of its deranged electrolytic balance.

There are three main types of secretory glands in the gastric mucous membrane. The distribution of these glands is shown in Diagram II.

(a) The Cardiac Glands. The glands extend from 5 - 4 cms. caudally (Plenk 1932). Their secretion is chiefly mucus as was first demonstrated by Bensley (1902). Bensley considered these glands to be "decadent or retrogressive structures derived from the fundal glands by the disappearance of their more highly specialised cells".

(b) Fundal and Body Glands. The "chief

/ glands

glands" which secrete both hydrochloric acid and pepsin occupy the whole of the gastric mucosa exclusive of the cardiac and pyloric areas.

The peptic or chief cells make up about two thirds of each gland and secrete pepsin from its precursor pepsinogen.

The parietal cells. These cells are separated from the lumen of the gland by the peptic cells, but are connected with it by inter-cellular capillaries.

(c) The Pyloric Glands. These glands extend from the pylorus some 4.5 - 5.5 cm. along the lesser curvature and 4 cms. along the greater curvature. The secretion of these glands is alkaline p_H. 7 - 8, the rate of secretion very slow 2-2.5 cc. per hour (Babkin 1928) and the content of proteolytic ferments nil (Ivy and Oyama 1921 and Babkin 1928). These facts seem to indicate that the antrum does not play an essential part in the digestion of proteins and that its main function is probably to reduce the acid of the fundus. It is doubtful whether the secretion of these glands 2-2.5 cc. per hour is sufficient to neutralise the acid secretion 50-60 c.c. per hour of the fundus. The first part of the duodenum by its alkaline secretion is usually able to complete neutrality of the contents by the time they reach this region.

PHASES IN GASTRIC SECRETION

(a) Cephalic Phase (psychic secretion).
Beaumont (1929), Pavlov (1911), Wolf and Wolff

/ (1943)

(1943), and others have demonstrated that the thought, suggestion, sight, smell, taste or chewing of palatable food causes an increased secretion of gastric juice through vagal stimulation. Babkin (1928) states that the digestive power of the vagal juice is much greater than that produced by the subsequent phases of secretion. The interesting observations of Wolf and Wolff on the effects of emotions on the gastric mucosa have recently become of increased importance, since the advent of supra-diaphragmatic vagal section. The most recent contribution of these workers has been their observations of the gastric mucosa following vagal section.

(b) Gastric Phase. When food is present in the stomach the secretion of gastric juice continues for a much longer period than can be accounted for by the psychic secretion.

Mechanical Stimulation - Pavlov demonstrated that mechanical stimulation of the gastric mucosa was entirely without effect upon the secretion of gastric juice. This was contradicted by the work of Ivy, Farrell and Leuth (1927). Lim, Ivy and McCarthy (1925) also succeeded in stimulating secretion by distending the stomach with a balloon. This is probably nature's provision for supplying an increased quantity of gastric juice to assist in the digestion of very large meals which distend the stomach.

Chemical Stimulation - It was noted by Pavlov that certain foods, e.g. meat and meat extracts, evoked

an abundant flow of gastric juice. In 1902 Bayliss and Starling discovered "secretin" from the upper bowel which on injection stimulated the free flow of gastric juice. This led Edkins a few years later (1906) to the discovery that extracts of the pylorus when injected gave a powerful secretion of gastric juice. He maintained that his substance, liberated by the pyloric antrum by food was carried by the bloodstream to the fundus where it provoked secretion of acid and pepsin. Edkins gave this hormone the name "gastrin". The validity of this theory is still contested. Poprelski (1920) demonstrated that histamine which caused increased gastric secretion was indeed "gastrin". Babkin (1928) believes they are not identical in that the gastric juice secreted in response to these two stimuli differ.

(c) Intestinal Phase. Lim, Ivy and McCarthy by using a completely transplanted denervated stomach pouch in an animal with an end to end oesophago-duodenal anastomosis noted that gastric juice appeared in the pouch from 1 - 6 hours after experimental feeding. Simple distention of the intestine failed to stimulate this flow of gastric juice in the pouch. These authors believe this to be unequivocal evidence of a hormonal mechanism. Either bi-products of digestion or some secretagogue from the upper intestine being carried via the bloodstream to the pouch.

(d) Continuous Phase. Carlson (1906) has described a fourth phase or continuous phase of

/ gastric

gastric secretion 2.50 c.c. per hour which he attributes to vagal tone.

THE EFFECT OF FAT ON GASTRIC SECRETION AND MOTILITY
(Enterogastrone)

Fat has the effect on the stomach of diminishing gastric secretion and depressing motility Ewald and Boas (1886). This has been shown by Farrell and Ivy (1926) to be due to the liberation of a hormone enterogastrone from the upper intestine to fat. Koraska et al (1937) were able, by making extracts of the intestinal mucosa which had been in contact with fat, to depress gastric secretion and motility. Ivy (1941) purified these extracts and found them to be similar to urogastrone present in the urine of normal people but not in those with duodenal ulcer. Urogastrone is sixteen times more potent than enterogastrone and has been used by Sandweiss and Friedman (1940) to prevent peptic ulcers in Mann-Williamson dogs. Hudbacker (1946) reported impressive results in the therapy of peptic ulcer by the use of urogastrone.

ABNORMAL PHYSIOLOGY PRESENT IN PEPTIC ULCER

The volume of gastric juice secreted per day was estimated by Rowntree (1922) to be in the region of 2000 c.c. Whether the increased secretion of gastric juice that accompanies peptic ulcer, particularly duodenal, is the cause of the ulcer or is merely an associated phenomenon, is not certain. The work of Mann and Williamson on dogs would suggest the former. Dragstedt by

/ using

using continual gastric suction in patients with duodenal ulcer noted the night secretion alone to be 2500 c.c. compared with the normal 200-500 c.c. This secretion is due to vagal stimulation and is reduced to normal by vagal section (Dragstedt 1947).

Pavlov (1911) held that the concentration of free hydrochloric acid secreted in the gastric juice was constant. A view which was challenged by Rosermann (1927) who believed that the concentration of the acid secreted depended on the stimulus. Recently Hollander (1938) Lim et al (1934) and Wang (1936) have shown that hydrochloric acid is secreted at a constant concentration isotonic with the blood. Hilmer (1934) noted that mucous and alkaline secretions, not the secretion of hydrochloric acid are responsible for the main variations in gastric acidity.

In peptic ulcer, therefore, the patients secrete more gastric juice of a constant acid concentration which fails to be adequately neutralised by the alkaline secretions present.

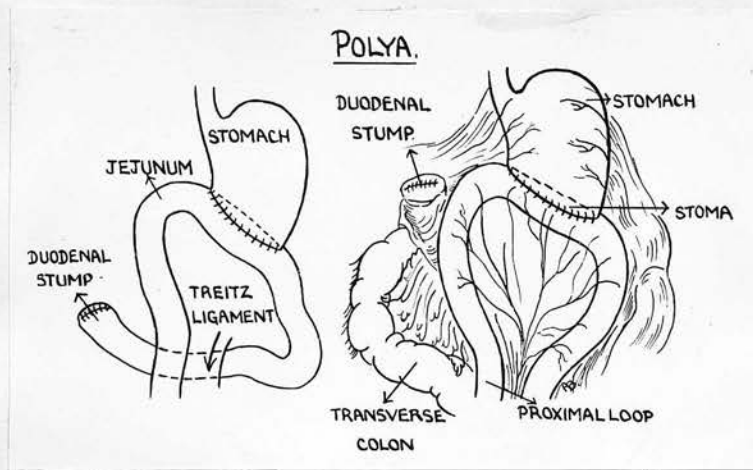
Pepsin is believed by some workers to be of equal or more importance than hydrochloric acid in the genesis of peptic ulcer. This ferment, like the free hydrochloric acid is also present in excess in patients with peptic ulcer, Barowsky, Tauber and Kleiner (1938) Kleiner (1945).

THE PHYSIOLOGICAL BASIS FOR PARTIAL GASTRECTOMY
IN PEPTIC ULCER

The object of this operation is to reduce

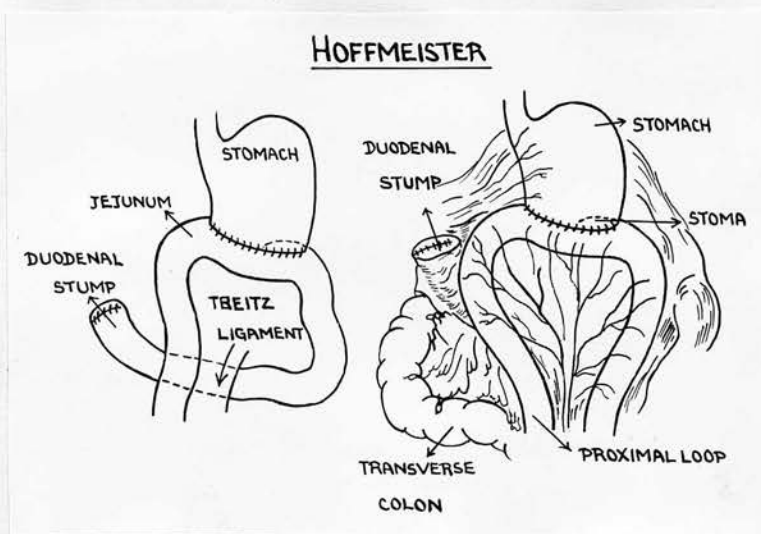
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D R A G R A M I I I



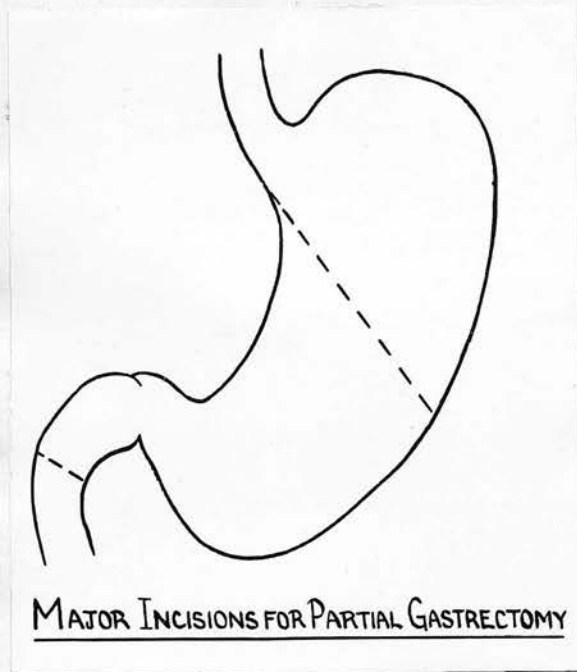
Polya operation. Stoma extends along total length of gastro-jejunal anastomosis.

D I A G R A M I V



Hoffmeister operation. Stoma only in lower third of gastro-jejunal anastomosis.

DIAGRAM V



Two major incisions used in partial
gastrectomy.

Note 1 - height of incision on lesser
curvature;

2 - oblique angle at which incision
reaches greater curvature.

gastric acid and to remove the ulcer bearing area. The latter is achieved by the removal of the pylorus and distal two thirds of the stomach, the former as the result of this removal which brings about the following changes.

(a) Based on Edkin's hypothesis of the secretion of a powerful secretagogue by the antrum, this operation by removal of the hormonal secreting tissue obliterates the gastric phase of secretion.

(b) It allows free regurgitation of the alkaline bile and pancreatic juices which exercise further reduction in gastric acidity.

In this thesis, which is chiefly a study of the physiology and its effects on the results of partial gastrectomy, it is not proposed to discuss the various operative techniques employed. It is pertinent, however, to review the results which have followed resections of various parts and amounts of the stomach and to note briefly the physiological rationale of the modifications of technique.

The operations employed throughout this series have been the Polya (Diagram III) in 43 instances and the Hoffmeister (Diagram IV) in 32 instances.

The site of the two major incisions is shown in Diagram V. The incision on the lesser curvature is commenced within an inch or so of the cardia. This incision is carried down obliquely to the greater curvature. The second incision is through the first part of the duodenum.

The commencing of the incision so high on the

/ lesser

lesser curvature is important. Firstly, it removes magenstrasse or ulcer bearing area of the stomach. Secondly, according to Klein (1925) who adhering to the view of Openchowski and Keith believed at the re-entrant angle there is a nodal centre which controls gastric peristalsis and secretion. Klein points out that the peristaltic waves of the lesser curvature commence at this point, the portion of the stomach above being merely a reservoir. This worker also attributes the niche or the greater curvature in cases of lesser curvature ulcer to be due to disturbances of this neurogenic mechanism. He cites instances of excessive gastric residue in the absence of stenosis and presumes this to be due again to neurogenic upset in the emptying mechanism. He believes it imperative for good results to excise completely this hypothetical nodal centre.

The obliquity of the incision from the lesser to the greater curvature is of importance. Many writers have stressed the importance of leaving a long spur on the greater curvature. Wide resection of the greater curvature as compared with a less radical excision produce only slightly less post-operative free hydrochloric acid. Should a stomal ulcer develop resection is more simple with a long than with a short, greater curvature spur.

The importance of removing the pylorus has been stressed by many workers. Smidt (1923) Wilhelmj, O'Brien and Hill (1936) noted a lowering of acidity following antral resection only. These

authors, by estimating the acidity before and after pylorotomy, concluded that the reduction in acidity was more than could be accounted for by the diluting and neutralising effect of the duodenal contents which regurgitated into the stomach.

Other investigators, however, have not substantiated these findings. Priestley and Mann (1932) reported inconstant results believing the pyloric mucosa played only a minor role in the regulation of gastric acidity. Lewis (1938) observed some reduction in acid when he excised the antral mucosa leaving the muscle intact. London (1925) reported that following antral excision in dogs there was a lowering of acidity in the Pavlov pouch. The acid, however, slowly returned to normal.

Portis and Portis (1926) Shapiro and Berg (1934) and Steinberg Brougher and Vedgoff (1927) have failed to note any reduction in the acid content of the Pavlov pouch following antral resection. All these findings tend to discredit Edkin's hypothesis and the practise of antral excision as a satisfactory means of inducing gastric acidity.

CLINICAL EVIDENCE

Whether or not the beneficial effects of partial gastrectomy are the result of removing the secretory area of Edkin's hormone have not yet been definitely established. Subtotal gastrectomy of the Polya type does not remove the acid

/ secreting

secreting area of the mucosa. However, since the operation does produce beneficial results clinically it is of interest to review the literature concerning the end results and post operative acidity that ensues from removal of various amounts and regions of the stomach in man. This subject has been the basis of an exhaustive paper by Wangansteen (1940) who has drawn his conclusions from both experimental and clinical evidence.

Extent of Resection - Those who advise or practise gastric resection for ulcer set as their objective the attainment of achlorhydria in the residual gastric segment. The opinions of surgeons differ as to the amount of gastric tissue which must be sacrificed to procure this objective.

Those who have favoured the "small gastric resection" with excision of the pylorus and Edkin's hormone include Von Haberer (1930) Lorenz and Schur (1922), Reinhoff (1939) and Smidt (1924). On the other hand, there are those who insist that, whereas antral excision will not ensure achlorhydria a more aggressive excision of the acid secreting area will. This second school is lead by Finsterer who by his operation of "pyloric exclusion" excises the main portion of the antrum and body of the stomach leaving the pylorus. Other surgeons, Shapiro and Berg, and Lewis believe that such radical excisions do not increase the likelihood of achlorhydria, nor do they afford added protection against the possibility of

/ recurrent

T A B L E I

(a)

HOLMAN AND McSWAIN.

a.	SITE OF LESION	No.	ANACIDITY	LOW ACID	NORMAL AND MODERATE
CENTRAL RESECTION	GU	6	2	2	2
	DU	25	0	4	21
		31	2 (6%)	6 (19%) (25%)	23 (75%)
b. RESECTION OF 1/2-2/3 INCLUDING PYLORES AND INCISURA ANGI	GU	12	9	3	0
	DU	34	16	9	9
		46	25 (54%)	12 (26%) (80%)	9 (20%)
c. RESECTION OF MORE THAN 2/3	GU	7	7	0	0
	DU	4	1	2	1
		11	8 (73%)	2 (18%) (91%)	1 (9%)

1. Much higher percentage of low acid levels and anacidity following two thirds resection compared with central resection.
2. Slight increase only in percentage of low acid levels and anacidity following major resections, i.e. more than two thirds, over moderate resections, i.e. half to two thirds.

(b)

WALTHAM WALTERS

AMOUNT OF STOMACH REMOVED	CASES	ANACIDITY
HALF	43	32 (74.6%)
MORE THAN HALF	65	50 (76.6%)

Anacidity increased only 2 per cent by major resections.

recurrent ulcer.

Emergy (1923) and Heuer and Holman (1943) believe that the stomach cannot be rendered achlorhydric as long as any gastric tissue remains and that gastric resection "per se" is the wrong approach to the whole problem, contending that gastric acidity plays only a minor part in the origin of peptic ulcers. Konjetzny (1935) approves of extensive resection but holds that gastric acidity has little to do with the genesis of peptic ulceration.

An increasing number of surgeons have found that extensive gastric resection although not affording absolute protection against recurrent ulcer is accompanied by fewer failures. Graham (1938) Lahey (1939) Ogilvie (1938) and Straus (1937).

RELATIONSHIP BETWEEN EXTENT OF GASTRIC RESECTION
AND POST OPERATIVE ACIDITY

Holman and McSwain (1943) made a very careful study of the relationship between the extent of gastric resection and the amount of post-operative acidity (Table I). This table shows that the percentage of cases of achlorhydria increased in proportion to the extent of the resection. However, the difference in the percentage of achlorhydria between the moderate resection (80 per cent) and the major resections (90 per cent) is not sufficiently great to warrant this latter operative procedure which carries a much higher

/ mortality

mortality. Heuer and Holman (1943) and Walters (1942) have published similar figures and likewise hold the belief that major resections (i.e. over 80 per cent) are not warranted in the therapy of peptic ulceration.

C H A P T E R VICLASSIFICATION OF RESULTS

In the study of a disease in which the aetiology is uncertain and in which great controversy exists as to the best form of therapy, our efforts should be concentrated on investigation of the cause. However, until the cause is known and a rational basis for treatment established, the soundest method of approach to actual therapy must be based on an honest evaluation of the results of our present therapy.

The results of partial gastrectomy for peptic ulcer are usually based on the site of lesion, the length of the follow-up period and the age of the patient. Such a method of presentation has, in the past, proved fairly successful and will be partially adopted in the present series. Although the above method of presentation is generally accepted there are no two papers in which the results are based on the same criteria. In reviewing the literature we have been impressed by the lack of definition which many authors attach to such terms as "satisfactory", "improved" or "cured". This lack of universality of definition leads to confusion for, a patient who by one author's criteria is "satisfactory" by another's may be "unimproved". It is, therefore, impossible under the existing conditions to compare the results of any two series and will remain so until a classification of results is established and adhered to by all authors reporting the results of

/ partial

partial gastrectomy.

It is illogical to compare the results in the present series, in which the patients were admitted to hospital for three to four days for full examination, with results based on answers to proformata sent to the patient's home. This latter method of investigation is open to a multiplicity of errors and should play no part in modern records published for statistical purposes.

It is pertinent at this junction to discuss our classification of results and the various criteria employed therein.

1. CURED

(a) Asymptomatic or symptoms of the most trivial nature only.

(b) Working capacity 100 per cent unless reduced by some concomittant lesion unassociated with the operation.

(c) No new symptoms attributable to the operation.

2. IMPROVED

(a) Not necessarily asymptomatic but relieved of the symptoms for which the operation was performed.

(b) Working capacity not less than pre-operative but need not be 100 per cent.

(c) No new symptoms of an incapacitating nature attributable to the operation.

3. IN STATU QUO

(a) May still be suffering from the symptoms

/ for

for which the operation was performed.

(b) Working capacity not less than pre-operative.

(c) The development of new symptoms attributable to the operation but not of a seriously incapacitating nature.

4. FAILURES

(a) May still be suffering from symptoms for which the operation was performed.

(b) Working capacity less than pre-operative.

(c) The development of new symptoms of a seriously incapacitating nature directly attributable to the operation.

In the drawing up of these four categories three main criteria were used. The relief of symptoms for which the operation was performed. The post operative working capacity and the presence or absence of new symptoms attributable to the operation.

CURES: This category includes all patients in whom the operation had caused complete relief of the ulcer symptoms.

A few complained that since the operation they had felt somewhat distended after a moderate-sized meal. These trivial symptoms, however, did not detract from the labelling of these patients as "cures". The working capacity in practically all these patients was 100 per cent. In a few cases it was 90 per cent. In some patients from whom no complaints were elicited we feel that the psychological effect of undergoing a major

operation may have influenced their attitude towards their post-operative health. Consequently patients who stated their working capacity to be 90 per cent and who were symptom-free were labelled "cures".

IMPROVED: This group included patients who suffered from post prandial distension but in whom the ulcer symptoms were relieved by the operation. A number of patients in this category had developed symptoms attributable to the operation such as hypoglycaemia or anaemia, but in no instance were the symptoms of an incapacitating nature. The working capacity of this group was never lower than the pre-operative working capacity, and in the majority of cases was substantially higher.

IN STATU QUO: This group included patients who "in toto" were not improved by the operation. In the majority of cases the symptoms of peptic ulceration had been relieved by the operation, but had been replaced by the symptoms of hypoglycaemia, anaemia, or severe post prandial distension causing incapacity to the same degree as did the ulceration. It should also be borne in mind that these patients had been subjected to a serious major operation carrying a considerable mortality and had derived no benefit from the procedure.

FAILURES: This group included all patients whose condition had deteriorated as a result of the operation. These patients had developed severe symptoms, hypoglycaemia, anaemia and post prandial distension and vomiting, directly

/attributable



attributable to the operation. The working capacity of all members of this group was reduced by the operation.

T A B L E II

GENERAL PRESENTATION OF RESULTS
OVERALL RESULTS ON ADMISSION

CURED		IMPROVED		I.S.Q.		FAILURE		SATISFACTORY		UNSATISFACTORY	
No	%	No	%	No	%	No	%	No	%	No	%
29	38.66	20	26.66	7	9.33	19	25.33	49	65.32	26	34.66

Note - results on admission

Satisfactory = cured + improved = 64.32 per cent

Unsatisfactory = in statu quo + failures = 34.66 per cent.

T A B L E III

RESULTS OF PARTIAL GASTRECTOMY FOR GASTRO-DUODENAL ULCER

UNITED KINGDOM	SATISFACTORY
STILL (1926)	90 PERCENT
LAKE (1928)	97.5 PERCENT
WALTON (1934)	70.2 PERCENT
KEMP (1946)	83 PERCENT
WATSON (1947)	94.6 PERCENT
<u>UNITED STATES</u>	
LEWISOHN GINZBURG (1927)	90 PERCENT
GATEWOOD (1930)	81.4 PERCENT
RIENHOFF (1932)	78 PERCENT
STRAUSS ETAL (1937)	88.6 PERCENT
CHURCH AND HINTON (1941)	90.67 PERCENT
HEUER (1944)	91.4 PERCENT
SAUNDERS (1945)	90 PERCENT
ALLEN AND WELSH (1946)	87 PERCENT

Figures for published results of partial gastrectomy for peptic ulcer. Results are considerably better than those for present series (Table II). Many authors do not define criteria for classification.

PRESENTATION OF RESULTSGENERAL

For the purposes of discussion the cases labelled "cures" and "improved" were classed as "satisfactory", while those labelled "in statu quo" and "failures" were classed as "unsatisfactory". Table II shows that the greatest number of patients fell into the "cured" category 38.66 per cent followed by the "improved" at 26.66 per cent. The percentage of "satisfactory" cases was therefore 65.32 per cent. The "unsatisfactory" cases made up 34.66 per cent of the total, 24 per cent as "failures" and 10.66 per cent as "in statu quo".

Table III shows the published results of partial gastrectomy for peptic ulcer by some of the leading authorities in this country and the U.S.A. Their results are, on the whole, very similar. In many of these articles there is no clear definition of the classification of results. The apparent disinterest of physicians on this topic is reflected in the literature, practically all of which has come from surgical clinics.

The results of the present series are not as satisfactory as those of the other authors. There may be several contributing factors. Firstly, the criteria for classification laid down in our series have been very strictly adhered to. Secondly, it may be that the follow-up of these patients, prior to their admission for this series has been inadequate. As Kemp (1946) has pointed out the

/ physician

T A B L E I V

OVERALL RESULTS FOLLOWING SIMPLE MEDICAL THERAPY

CURED		IMPROVED		I.S.Q		FAILURE		SATISFACTORY		UNSATISFACTORY	
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
30	40	24	32	6	8	15	20	54	72	21	28

Note - Improvement in satisfactory results following simple medical therapy, i.e. 65.32 per cent to 72 per cent.

physician has three duties to his patient in regard to surgery for peptic ulcer. He must have clear cut indications in his own mind, he must know the risks and drawbacks of the operation and he must follow up the late results of his advice. This failure of adequate follow up is clearly shown by the number of patients in this series suffering from post-gastrectomy anaemia.

OVERALL RESULTS FOLLOWING SIMPLE MEDICAL THERAPY

The improvement in results following the correction of anaemia or alteration in diet for post prandial distension is shown in Table IV. This simple therapy brought the percentage of satisfactory results from 65.32 per cent to 72 per cent. We feel that a better follow up chiefly on the part of the physician would go far in improving the late results of the operation. For example, four patients with a post-gastrectomy haemoglobin of below 60 per cent complained of severe exhaustion and as a result had to be classified as "failures". The administration of ferrous sulphate gr. III T.I.D. for two months raised the category of one to "cured" and the other three to "improved". We feel that a more adequate follow up would have prevented the haemoglobin from reaching these low levels which made an otherwise successful operation a failure and tended to discredit the procedure.

FACTORS PRODUCING UNSATISFACTORY RESULTS

Table V illustrates the principle factors causing the unsatisfactory results. In many of

/ the

FACTORS PRODUCING UNSATISFACTORY RESULTS
CLASSIFICATION OF UNSATISFACTORY RESULTS.

	FACTOR	NUMBER	PERCENTAGE
1	HYPOGLYCAEMIA	11	42.31
2	ANAEMIA	3	11.54
3	POST PRANDIAL DISTENTION AND VOMITING	3	11.54
4	LOSS OF ENERGY	9	34.61
	TOTAL	26	100.00

Note - Commonest cause of unsatisfactory results was post prandial hypoglycaemia 42.31 per cent of failures.

T A B L E VI

RESULTS ON ADMISSION

RESULTS	CURED		IMPROVED		I.S.Q		FAILURE		SATISFACTORY		UNSATISFACTORY	
	No	%	No	%	No	%	No	%	No	%	No	%
MALES 64	29	45.31	17	26.56	4	6.25	14	21.87	46	71.87	18	28.22
FEMALES 11	0		3	27.27	2	18.18	6	54.54	3	27.27	8	72.72

Note - On admission poor results in females compared with males, 27.27 per cent to 71.87 per cent satisfactory.

T A B L E VII

RESULTS AFTER SIMPLE MEDICAL THERAPY

RESULTS	CURED		IMPROVED		I.S.Q		FAILURES		SATISFACTORY		UNSATISFACTORY	
	No	%	No	%	No	%	No	%	No	%	No	%
MALES 64	29	45.31	19	29.68	5	7.81	11	17.19	48	75.0	16	25.0
FEMALES 11	1	9.09	5	45.45	1	9.09	4	36.36	6	54.5	5	45.45

Note - Increase in percentage of satisfactory results in females following simple medical therapy i.e. 27.27 per cent to 54.54 per cent.

the cases several factors were operating. The table indicates the principle factor only. Sufficient it is to note here that post prandial hypoglycaemia was the commonest cause of an unsatisfactory result in this series. This topic, together with post-gastrectomy anaemia, post prandial distension and post operative loss of energy will be discussed at length in later chapters.

SEX RELATIONSHIP TO RESULTS

In this series the results show a very marked sex difference (Table VI - Results on Admission). Whereas 71.87 per cent of the males were "satisfactory" only 27.27 per cent of the females fall into this group.

The high percentage of "failures" amongst the females was due to several factors; they were more prone to suffer from post-gastrectomy anaemia than the males. Indeed, three of the "failures" in this group were due to anaemia which, with correction, raised one to a "cure" and two to "improved". Dietary treatment of post prandial hypoglycaemia raised two patients to "improved" one from a "failure" and one from "in statu quo".

Table VII shows the improvement following simple medical therapy. The percentage increase in satisfactory results amongst the females was 27.3 per cent compared with only 3 per cent amongst the males. This table again illustrates what improvement in results might be expected from a more adequate follow up of cases.

T A B L E VIII

RESULTS OF PARTIAL GASTRECTOMY IN RELATION TO SITE OF LESION.

SITE OF LESION	No	CURED		IMPROVED		I.S.Q.		FAILURES		SATISFACTORY		UNSATISFACTORY	
		No	PERCENT	No	PERCENT	No	PERCENT	No	PERCENT	No	PERCENT	No	PERCENT
DUODENAL	40	17	42.5%	11	27.5%	3	7.5%	9	22.5%	28	70%	12	30%
GASTRIC	27	10	37.03%	8	29.63%	2	7.41%	7	25.93%	18	66.66%	9	33.33%
STOMAL	8	2	25%	1	12.5%	2	25%	3	37.5%	3	37.5%	5	62.5%

On Admission - highest percentage of satisfactory results were for duodenal group 70 per cent; gastric group 66.66 per cent; stomal ulcer very poor 37.5 per cent.

T A B L E IX

RESULTS FOLLOWING SIMPLE MEDICAL THERAPY

SITE OF LESION	No	CURED		IMPROVED		I.S.Q.		FAILURES		SATISFACTORY		UNSATISFACTORY	
		No	PERCENT	No	PERCENT	No	PERCENT	No	PERCENT	No	PERCENT	No	PERCENT
DUODENAL	40	17	42.5%	12	30.0%	4	10.0%	7	17.5%	29	72.5%	11	27.5%
GASTRIC	27	11	40.81%	10	37.03%	0	0%	6	22.22%	21	77.84%	6	22.22%
STOMAL	8	2	25%	2	25.0%	2	25.0%	2	25.0%	4	50.0%	4	50.0%

Following simple medical therapy the gastric ulcer group were most satisfactory 77.84 per cent; duodenal 72.5 per cent. Stomal ulcer group remained poor at 50 per cent.

RESULTS OF PARTIAL GASTRECTOMY IN RELATION
TO SITE OF LESION

It is a well established fact that the results of this operation vary with the site of the lesion.

It is evident from Table VIII (Category on admission) that the results were best when the operation was performed for duodenal ulceration i.e. 70 per cent "satisfactory", next best for gastric ulcer only 3.4 per cent less at 66.66 per cent, and poorest results by far were for stomal ulcer 37.5 per cent. Most authors Watson (1947) Heuer (1944) report the best results follow the operation when performed for gastric ulcer.

Table IX illustrates the improvement following simple medication. From these figures it would appear that with adequate follow up facilities resection for gastric ulcer is accompanied by the best results. In the absence of an adequate follow up, however, this group is more prone than the duodenal group to lapse into the unsatisfactory category.

DUODENAL ULCER

The results of partial gastrectomy for this lesion were, on the whole very gratifying, 42.5 per cent were "cured" and 27.5 per cent "improved". This figure of 70 per cent "satisfactory" compares favourably with the results of medical therapy. Heuer (1944) and Sanders (1945) both state that the best results which can be expected from medical therapy is 55 per cent "satisfactory". Our

/ figure

T A B L E X

**RESULTS OF PARTIAL GASTRECTOMY
FOR DUODENAL ULCER**

AUTHORS	SATISFACTORY
FINSTERER (1926)	94 %
FINNEY (1930)	86 %
HEUER (1944)	81.9%
SANDERS (1945)	90%
WATSON (1947)	92.7%

Published results of partial gastrectomy for duodenal ulcer.

Note - The higher percentage of satisfactory results claimed by these authors compared with the 70 per cent satisfactory results of the present series.

T A B L E XI

RESULTS OF DUODENAL ULCER TREATED BY PARTIAL GASTRECTOMY

LESION	No	CURED		IMPROVED		I.S.Q		FAILURES		SATISFACTORY		UNSATISFACTORY	
		No	PERCENT	No	PERCENT	No	PERCENT	No	PERCENT	No	PERCENT	No	PERCENT
OVERALL	40	17	42.5%	11	27.5%	3	7.5%	9	22.5%	28	70.0%	12	30.0%
PRIMARY	25	13	52.0%	6	24.0%	1	4.0%	5	20.0%	19	76.0%	6	24.0%
SECONDARY	15	4	26.66%	5	33.33%	2	13.33%	4	26.66%	9	60.0%	6	40.0%

Duodenal Ulcer.

Note - Cure rate in primary operations was double that in secondary operations 52 to 26.66 per cent. Percentage of satisfactory results similarly greater in primary cases i.e. 76.0 to 60.0 per cent.

figure of 70 per cent is again below that given by most authors (Table X).

Again the reason for our figure may be the more rigid criteria we have used. All the authors, with the exception of Watson, have published results either in the U.S.A. or Great Britain before 1939. We believe that the patient with a partial gastrectomy was in much better health on the pre-war British diet and the present-day American diet. The present British diet may, therefore, be a factor contributory to our less favourable results.

We have divided the cases of duodenal ulcer into two groups:

(a) Primary Duodenal. Those patients who, prior to partial gastrectomy, had had no surgical intervention on the stomach or duodenum.

(b) Secondary Duodenal. Those patients who, prior to partial gastrectomy, had been subjected to operative interference on their stomach or duodenum. This constituted the closure of one or more perforations, except in one patient in whom the left vagus had been sectioned below the diaphragm.

RESULTS OF DUODENAL ULCER

TREATED BY PARTIAL GASTRECTOMY

Table XI classifies the results of primary and secondary operations on duodenal ulcers. The "cure" rate of the primary group is double that of the secondary and the "satisfactory" results are better by 16 per cent. The reasons for their

/ differences

T A B L E XII

RESULTS OF PARTIAL GASTRECTOMY FOR GASTRIC ULCER

SEX	CURED	IMPROVED	I. S. Q.	FAILURES	SATISFACTORY	UNSATISFACTORY
	NO. PERCENT	NO. PERCENT	NO. PERCENT	NO. PERCENT	NO. PERCENT	NO. PERCENT
MALES 19	10 52.63%	5 26.31%	0 0%	4 21.06%	15 78.9%	4 21.06%
FEMALES 8	0 0	3 37.5%	2 25.0%	3 37.5%	3 37.5%	5 62.5%
OVERALL 27	10 37.04%	8 29.63%	2 7.41%	7 25.93%	18 66.67%	9 33.33%

On admission

- Note - 1 - High percentage of satisfactory results in males 78.9 per cent.
 2 - Low percentage of satisfactory results in females 37.5 per cent.

T A B L E XIII

RESULTS OF PARTIAL GASTRECTOMY FOR GASTRIC ULCER FOLLOWING SIMPLE MEDICATION

SEX	CURED	IMPROVED	I. S. Q.	FAILURES	SATISFACTORY	UNSATISFACTORY
	NO. PERCENT	NO. PERCENT	NO. PERCENT	NO. PERCENT	NO. PERCENT	NO. PERCENT
MALES 19	10 52.63%	5 26.31%	0 0%	4 21.06%	15 78.9%	4 21.06%
FEMALES 8	1 12.5%	5 62.5%	0 0%	2 25.0%	6 75.0%	2 25.0%
OVERALL 27	11 40.81%	10 37.03%	0 0%	6 22.16%	21 77.84%	6 22.16%

Following simple medical therapy

- Note - 1 - No improvement in males 78.9 per cent satisfactory.
 2 - Females more satisfactory by 37.5 per cent.

30.
differences are probably multiple. As the members of the secondary group have all had one or more perforations it is possible that their ulcers were of a more virulent nature.

The adhesions resulting from a perforation render the removal of the first part of the duodenum much more difficult, indeed in some cases it is impossible to remove it. Consequently the group with the secondary operation includes fewer patients rendered achlorhydric. This factor is more fully discussed in Chapter

GASTRIC ULCER

The results on admission were slightly less satisfactory than those for duodenal ulcer. This was reversed following simple medical therapy.

Table XII illustrates the sex differences in the results of partial gastrectomy for gastric ulcer. The interesting feature is the relatively high percentage of satisfactory results in the males 78.9 per cent against the very low figure of 37.5 per cent amongst the females.

RESULTS OF PARTIAL GASTRECTOMY FOR GASTRIC ULCER

FOLLOWING SIMPLE MEDICATION

Following simple medication the figures were unchanged in the males but markedly improved in the females (Table XIII) in which group the "satisfactory" cases rose from 37.5 to 75 per cent. The apparent "failure" of three women in this group was in two instances due to hypoglycaemia and in one to severe anaemia. All three responded to therapy which permitted their being placed in a

/ higher

T A B L E X I V

PUBLISHED RESULTS OF PARTIAL GASTRECTOMY
FOR GASTRIC ULCER

AUTHOR	SATISFACTORY
FINSTERER (1926)	103 OF 105 CURED
WRIGHT (1928)	81.81 %
FINNEY (1930)	88.2 %
DOUGLAS (1930)	75.0 %
CLAGETT (1940)	94.1 %
LAWSON (1944)	100 %
HEUER (1944)	94.34 %
SANDERS (1945)	90.0 %
WATSON (1947)	96.6 %

Note - The figure of 70 per cent satisfactory results for gastric ulcer is much poorer than those of the published figures, apart from Douglas and Wright.

T A B L E X V

RESULTS OF PARTIAL GASTRECTOMY FOR STOMAL ULCER ON ADMISSION

No.	CURED		IMPROVED		I.S.Q.		FAILURES		SATISFACTORY		UNSATISFACTORY	
	No.	PERCENT	No.	PERCENT	No.	PERCENT	No.	PERCENT	No.	PERCENT	No.	PERCENT
8	2	25.0%	1	12.5%	2	25.0%	3	37.5%	3	37.5%	5	62.5%
AFTER MEDICATION												
8	2	25.0%	2	25.0%	2	25.0%	2	25.0%	4	50.0%	4	50.0%

The results for stomal ulcer

Note poor results

1. 37.5 per cent satisfactory on admission.
2. 50 per cent satisfactory after medical therapy.

higher category.

Why the percentage of satisfactory cases in the present series does not approach those of the other authors (Table XIV) (apart from Wright and Douglas) to within less than 10 per cent. may be attributed to the factors previously mentioned.

The only series carried out in this country since 1939 is that of Watson. His figure of 96.6 per cent "satisfactory" results is a little difficult to accept without more detailed knowledge of his criteria for classifying results. For example his "improved" cases are those "who do complain of a definite upset in the way of flatulence, fullness, or vomiting". All this group say they have benefitted from the operation. Some have lost work on account of their "upset". The improvement in such cases must be very slight indeed, and according to our classification would certainly be no better than "in statu quo". A patient who complains of vomiting and loses work would seem to be no better off than he was before the operation.

STOMAL ULCER

This group includes both stomal ulcers and ulcers which have failed to heal following gastro-enterostomy. The results were poorest following this lesion. Table XV shows the result on admission and following simple medication.

Following an alteration in diet one patient was raised from "failure" to "improved".

T A B L E X V I

RESULTS IN RELATION TO PATIENT'S AGE

AGE	CURED		IMPROVED		I.S.Q.		FAILURES		SATISFACTORY		UNSATISFACTORY	
	No.	PERCENT	No.	PERCENT	No.	PERCENT	No.	PERCENT	No.	PERCENT	No.	PERCENT
20-39	7	41.18%	5	29.41%	1	5.88%	4	23.53%	12	70.59%	5	29.41%
40-49	12	42.86%	5	17.85%	5	17.85%	6	21.44%	17	60.71%	11	39.29%
50-59	8	34.78%	9	39.13%	0	0%	6	26.09%	17	73.91%	6	26.09%
60+	2	28.57%	1	14.29%	1	14.29%	3	42.85%	3	42.85%	4	57.15%

Progressive decline in percentage of cures and satisfactory results accompanying increase in age.

AGE IN RELATION TO RESULTS

For the purposes of this survey the patients have been divided into four age groups 20 - 39, 40 - 49, 50 - 59, and 60 and over (Table XVI).

The first three age groups showed comparable results. The percentage of "satisfactory" results falling between 60.71 per cent and 73.91 per cent. The best figures are for the 50 - 59 age group. There is a decided fall in the percentage of satisfactory results after the age of 60 - only 42.85 per cent. The commonest cause of an "unsatisfactory" result in this age group was post prandial hypoglycaemia which did not respond to therapy as favourably as in the younger age group.

POST OPERATIVE PERIOD IN RELATION TO RESULTS

Sara Jordan (1941) stated that the follow up period of a patient treated for peptic ulcer must continue so long as the patient was living. Hollander and Mage (1943) in reviewing the methods of evaluating the results of partial gastrectomy for peptic ulcer drew attention to the method of comparing the results of patients in different post operative periods. By this method we are admittedly taking samples of the population who have survived the operation for different lengths of time, and who are therefore not truly comparable. There is no doubt that the principle of follow up in continuity advocated by St. John and his associates (1930 and 1939) has much to recommend it. By this method each patient is

T A B L E X V I I

RESULTS IN RELATION TO POST-OPERATIVE PERIOD

POST-OPERATIVE PERIOD	CURED		IMPROVED		I. S. Q.		FAILURE		SATISFACTORY		UNSATISFACTORY	
	No.	PERCENT	No.	PERCENT	No.	PERCENT	No.	PERCENT	No.	PERCENT	No.	PERCENT
1- 24	17	41.46%	11	26.83%	4	9.75%	9	21.95%	28	68.29%	13	31.70%
25-60	7	35. %	6	30. %	2	10. %	5	25. %	13	65. %	7	35. %
60+	5	35.71%	3	21.43%	1	7.14%	5	35.71%	8	57.14%	6	42.85%

Note - Progressive decline in satisfactory results with increase in post-operative period.

seen at regular intervals so that his post-operative history can be followed with the progress of time. One important development of this method might be the charting of "failures" at various times after the operation. Adhering to such a council of perfection the patients must be followed up for the rest of their lives. Such a follow up was impossible in the present series where it was necessary to adopt the somewhat unsatisfactory categorisation period of patients into three main post operative groups according to the length of the post operative period. The periods of 0 - 2 years, 2 - 5 years and over 5 years (after Heuer) were used. The average follow up period for this series was 36.5 months.

The fact that the results of partial gastrectomy tend to deteriorate with time is shown in the figures of Heuer, Watson and others. In our series there was very little difference between the figures for the 0 - 2 and 2 - 5 year periods. The percentage of "cures" is highest in the 0 - 2 year period 41.64 per cent, but the overall percentage of "satisfactory" results is only slightly above that for the 2 - 5 year period (i.e. 68.29 per cent to 65 per cent). The period of 5 years and over contains only 57.14 per cent of "satisfactory" results and as shown in Table XVII the decline in results is fairly constant from the fifth year onwards.

CHAPTER VIIIINDICATIONS FOR PARTIAL GASTRECTOMY

In the present series the indications for partial gastrectomy have been, in the majority of cases, the result of failure of medical therapy. Pain, pyloric stenosis, and haemorrhage have been due to the inability of medical therapy to arrest the progression of the ulcer process. The ulcer has either failed to heal under this regime resulting in pain, or there has been further breaking down of the ulcer with haemorrhage, or a series of events of alternating breaking down and healing of the ulcer which have resulted in cicritical contraction and stenosis of the pyloric outlet. Surgical failures have not been exempt. Stomal ulcer and recurrent ulcer after gastro-enterostomy have been attributed to several causative factors, failure to assess the case adequately before performing the gastro-enterostomy e.g. the carrying out of a gastro-enterostomy in a young man with a duodenal ulcer and a high free acid, and failures in technique such as poor positioning of the stoma. It should be borne in mind that some of these failures occurred in patients who had been operated on many years ago when we were not so enlightened in the poor results of gastro-enterostomy. A further, and probably the most important factor contributing to the surgical failures has been the "ulcer diathesis". Patients in whom this constitutional peculiarity is marked fail completely to respond

T A B L E XVIII

PRIMARY INDICATIONS FOR PARTIAL GASTRECTOMY

INDICATION	TOTAL NO.	PERCENTAGE	AVERAGE AGE	AV. PRE. OP. SYMPTOM	AV. POST. OP. PERIOD	AV. POST. OP. FREE ACID	MALE	FEMALE	SITE OF LESION	
									DU	G.U.
PAIN	41	54.66	46.1	14.5 YEARS	33 MONTHS	65.6	34	7	24	17
STENOSIS	11	14.66	38.5	10 YEARS	31 MONTHS	63.0	11	0	9	2
RECURRENT HAEMORRHAGE	6	8.00	45.82	12.5 YEARS	37.3 MONTHS	37.33	6	0	4	2
RECURRENT PERFORATION	3	4.00	46.66	3 YEARS	15.6 MONTHS	44	2	1	3	0
MALIGNANCY [?]	6	8.00	56.66	12.5 YEARS	71.3 MONTHS	35	4	2	0	6
STOMAL ULCER	8	10.66	51.25	16.12 YEARS	32.38 MTHS	38	7	1	40	27

- Note - 1. Commonest indication for gastric resection was intractable pain.
2. Long history of pre-operative symptoms.

to any form of therapy medical or surgical and continue to develop recurrent ulcers in spite of all our strivings.

INDICATIONS

1. INTRACTABLE PAIN - Pain which is the commonest symptom of peptic ulcer was present in 70 of the 75 cases under review. Intractable pain, which fails to be relieved by adequate medication, which is of sufficient severity to handicap the patient from earning a livelihood, and which occurs in a person under 50 years of age is "per se" an indication for partial gastrectomy.

Intractable pain constituted the commonest indication for partial gastrectomy in this series. In 41, or 54.66 per cent, of cases it was this symptom which outweighed medical therapy in favour of surgical intervention. In most of the duodenal cases the pain was associated with a greater or lesser degree of stenosis.

The sex ratio for this indication was approximately five males to one female. (Table XVIII). The site of the lesion was duodenal in 24 instances and gastric in 17. The fact that these patients were not subjected to partial gastrectomy without an adequate attempt at previous medical therapy is borne out by the fact that the average duration of symptoms before operation was 14.5 years. All patients had been hospitalised under a medical regime at least twice previously and in some cases as many as six times. These findings adequately fulfil

Ryle's (1934) criterion that no patient with a peptic ulcer should be subjected to surgery unless the symptoms have been present for at least five years.

Patients over 50 years of age tend to have less free hydrochloric acid in their gastric juice and the operation of gastro-enterostomy with its lower mortality may suffice to bring about relief of symptoms. This group of patients, with their low free acid, still further reduced by gastro-enterostomy do not run the same risk of stomal ulcer as the younger age group with their high free acid. This group was on the average 46.1 years of age and exhibited a higher pre-operative free acid than any of the other groups - 45.6 units.

2. PYLORIC STENOSIS - Pyloric stenosis due to organic occlusion not yielding to medical therapy constituted the indication for partial gastrectomy in 12, i.e. 16 per cent of cases. Again all the patients of this group had been hospitalised previously on the medical side on from one to six occasions and had failed to procure permanent relief from the orthodox medical therapy associated with nightly gastric lavage and in some instances continuous gastric suction and intravenous saline.

This group was composed entirely of males with an average symptomatology of ten years duration. The site of the primary lesion was in nine cases duodenal and in two cases pre-pyloric. As with intractable pain, however, gastro-enterostomy is

T A B L E X I X

LIABILITY OF PEPTIC ULCERS TO BLEED.

STATISTICS REPORTED BY	PERCENTAGE OF BLEEDING ULCERS
BLACKFORD ET. AL	18.00
ALLEN	35.00
BROWNE AND M ^S HARDY	30.40
WHERRIT	15.30
TURNBULL AND SAGI	16.30
PHILLIPS	26.00
PRESENT SERIES	44.00

Note - High percentage of bleeding in the present series.

only a safe procedure in the later age groups with a low free acid. Of the patients with pyloric stenosis the average age was 38.5 years and the free acid in the pre-operative test meal 65 units. These patients were, therefore, young, had a high free acid and consequently were subjected to partial gastrectomy rather than gastroenterostomy.

3. HAEMORRHAGE FROM PEPTIC ULCER - It is not possible to estimate accurately the percentage of massive haemorrhages from the alimentary tract that are due to peptic ulceration. In a certain number of cases labelled "peptic ulcer haemorrhage" in the various statistical papers the diagnosis of ulcer was not proven. Indeed the only cases which can be accepted with finality are those which have been proved at operation or autopsy. Statistics from latter source would also be unreliable since not over 15 per cent of all massive haemorrhages terminate in the surgical amphetheatre or post mortem room.

The incidence of bleeding in cases of peptic ulcer is shown in Table XIX. The figure for the present series of 33 or 44 per cent is rather higher than that of other authors - this may be due in some measure to the relatively large proportion of stomal ulcers.

In 19 of the 33 cases the bleeding occurred as haematemesis and in 15 as melaena only. The presence of melaena had, in some cases, to be taken on the patient's word. Only "black or

T A B L E X X

RELATIVE LIABILITY TO BLEED OF DUODENAL, GASTRIC AND STOMAL ULCERS.

STATISTICS REPORTED BY	DUODENAL	GASTRIC	STOMAL
HURST	24 PERCENT	20.9 PERCENT	48.5 PERCENT
HURST AND RYLE	28 "	33 "	46 "
ALLEN	39 "	26 "	89 "
ABRAHAMS	25 "	20 "	—
PRESENT SERIES	42.5 "	40.8 "	75 "

Note - 1. High incidence of bleeding in duodenal and gastric ulcer in present series compared with published figures.

tarry" stools noticed by the patient as such when he was not taking iron or bismuth were accepted as melaena.

These figures, however, do not represent the true incidence of bleeding in peptic ulcer for as Bockus (1943) points out less than 20 per cent of patients with peptic ulcer are admitted to hospital. Hospital cases include the great majority of severely bleeding ulcers, so that, the true incidence of bleeding is probably in the region of 5 per cent.

Site of Lesion in Relation to Bleedings (Table XX)

Stomal and Recurrent ulcers showed the highest incidence - six out of eight cases. This would appear to be the findings of other observers. Allen (1937) gives the figure as 89 per cent of 35 cases and Hurst (1937) as 48.5 per cent of 97 cases.

Gastric and duodenal ulcers show very much the same tendency to bleed. In the present series the figure was slightly higher for duodenal ulcers, 42.5 per cent to 40.8 per cent. Again this has been the finding of other workers (Table XX). Abrahams (1934), Allen (1937) and Hurst found the incidence to be very slightly higher in duodenal ulcers, whereas Hurst and Ryle (1937) in another series found the incidence slightly greater in gastric ulcers.

Stomal ulcers showed the greatest tendency to bleed. The incidence of haematemesis as a manifestation of bleeding was much greater with

ulcers at this site than with those of the stomach or duodenal.

Pathology of Bleeding Peptic Ulcer.

Exposure of ulcers associated with massive haemorrhage at operation or at post mortem in those dying from haemorrhage clearly demonstrate why some patients succumb and by inference why the majority recover.

As Heuer (1944) points out it is the location of the ulcer, its unyielding fibrous base, and primarily the kind and size of the vessel eroded by the pathological process which are the determining factors. In Heuer's experience all patients who have died and come to autopsy or who, through operative interference, have had the ulcer exposed, the ulcer has been located on the posterior duodenal wall and has eroded the pancreas and given rise to haemorrhage through the erosion of the pancreatico - duodenal artery or one of its major branches.

Of the gastric lesions the lesser curvature ulcer implicating the right or left gastric artery or one of its major branches is the common finding. The bleeding is therefore arterial in nature and is derived from a single source rather than from capillary oozing from a diffusely congested mucosa.

From a review of the literature, massive haemorrhage in 73 per cent of cases was caused by chronic ulcers and in 27 per cent of cases by acute ulcers. Ulcers on the anterior wall of the duodenum are less likely to cause massive

/ haemorrhage

T A B L E X X I

MORTALITY IN HAEMATEMESIS AND MELAENA.				
		SELECTION OF CASES	No	MORTALITY %
UNITED KINGDOM	22 GENERAL PRACTITIONERS (BABEY & HURST)	ULCERS IN G.P.	525	1.3
	BABEY AND HURST (GUYS HOSPITAL)	ULCERS	82	4.8
	HURST (NEW LODGE CLINIC)	ULCERS	161	1.9
	RYLE (LONDON)	ULCERS IN PRIVATE P.	153	2.6
	BULMER (BIRMINGHAM)	ULCERS	578	10.7
	CULLINAN AND PRICE (LONDON)	ULCERS	105	18.1
	GORDON-TAYLOR (LONDON)	ULCERS TREATED MEDICALLY	124	12.5
	BENNE ET AL (LONDON)	ULCERS	122	10.0
UNITED STATES	BROWNE AND HARDY (N.O.)	ULCERS	131	6.9
	JANKELSTON AND SEGAL (BOSTON)	ULCERS	200	10.5
	HINTON (NEW YORK)	ULCERS	123	9.0
	TURNBULL AND SAGI (CHICAGO)	ULCER-PRIVATE CLINIC	80	2.5
	BLACKFORD AND COLE (SEATTLE)	MASSIVE HAEMORRHAGE	57	16.8
	WHERRIT (PHILADELPHIA)	" "	72	11.0
	MARSHALL AND KIEFER (BOSTON)	ULCERS	108	4.6
EUROPE	MEULENGRACHT (DENMARK)	ULCERS	368	1.3
	CHRISTIANSEN (DENMARK)	ULCERS	289	7.9

Published figures for Mortality
from haematemesis.

haemorrhage than those on the posterior wall and ulcers of the fundus less dangerous with respect to haemorrhage than those of the lesser curvature.

It is clear, therefore, that there are two types of haemorrhage from peptic ulcer. One, the less common and more serious from a chronic ulcer on the posterior duodenal wall and on the lesser curvature. The other, less, serious, usually recovered from and derived from acute and chronic ulcers in areas in which large arterial branches are absent. In the former it is doubtful if permanent control of haemorrhage is possible by any method short of radical surgery.

Mortality from Bleeding Ulcer.

(a) Under medical Regime - is given in Table XXI. It will be noted from this table that the mortality varies greatly and it is difficult from the statistics available to establish a definite mortality figure. Cases and samples vary tremendously from paper to paper and insufficient proof exists for accepting many of the reported cases as actually bleeding from an ulcer.

The high mortality figure of Blackford and Cole (1939) in Seattle of 16.8 per cent of 57 cases is based on the inclusion of cases with very massive haemorrhage whereas the 1.3 per cent of 368 cases reported by Meulengracht (1937) includes many episodes of minor bleeding. In the latter series only one third of the cases showed radiological evidence of ulcer. It is, of course, probable that the ulcer or erosion in many of Meulengracht's

cases had healed before the X-Ray was taken. It is obviously not fair to compare such a series with that of Blackford and Cole.

There appears to be general agreement that the average mortality for all cases of haemorrhage from peptic ulcer admitted to large city hospitals is in the region of 10 per cent. This figure being the same in Great Britain and the U.S.A. of patients with bleeding ulcer, the fifth decade contained the highest number. The average age for the present group being 45 years. Wherritt also found the highest incidence in the 40 - 50 age group. The number of females in our series is too small to be of real significance but bleeding occurred in 36.4 per cent compared with 46.8 per cent of males.

Social Factor.

The mortality of 10 per cent is for the hospital class of patient. Substantially lower figures have been reported from private clinics, for example, Marshall and Kiefer (1939) 4.5 per cent from the Lahey Clinic. Avery Jones in London states that the mortality rate for his patients in the Central Middlesex Hospital is double that of his patients in Guy's Hospital under similar therapy. This lower mortality in Guy's he attributes to the better social class of patient admitted. Such patients report to their doctor immediately they have a haematemesis or notice melaena. Whereas the Central Middlesex Hospital patients, of lower income and intelligence will

carry on at work in spite of "tarry stools" until they are forced to stop from sheer fatigue; thus the earlier admission of the Guy's patients was responsible for the lower mortality.

Another fact in the production of the lower mortality in the private clinic is that irrespective of the social status of the patient in the case of an emergency from massive haemorrhage the patient will be admitted to a large city hospital rather than a private clinic. The fact that only the more severe cases of haemorrhage reach hospital has been shown by Babey and Hurst (1936) who, after reviewing the records of 22 general practitioners could find only eight deaths of the 525 patients with haematemesis or melaena from peptic ulcer treated at home. In light of this finding these authors concluded that the mortality from haematemesis or melaena was probably about 3 per cent.

Blackford and Cole drew attention to the fact that 78 per cent of their mortalities occurred during the first admission to hospital for haemorrhage. Cullinan and Price (1932) found that the mortality increased with each exacerbation of haemorrhage, while the patient was in hospital and that relatively few of the fatalities occurred during the first massive bleeding.

Surgery in the Treatment of Bleeding Ulcer.

(b) The problem of whether or not to operate on a bleeding peptic ulcer has long been a field of conflict between surgeon and physician. Much of the

literature on the subject is written with considerable bias which detracts from its real value. A very careful analysis of the material presented in the various series is therefore necessary before any conclusions can be drawn.

Physicians such as Meulengracht and Hurst who quote mortalities of 1.3 and 4 per cent respectively naturally tend to discredit surgery. On the other hand, surgeons such as Finsterer (1936) and (1939) and G.G. Taylor (1934) and (1937) who report mortalities of 5.1 and 9 per cent state that all, except acute ulcers, should have a partial gastrectomy performed immediately.

Finsterer's 5.1 per cent mortality is based on a series of 78 good risk cases operated on 24-48 hours after the initial haemorrhage. It is very probable that the mortality rate would have been the same without operation. In a second series of 69 cases reported by this author in which the patients were operated on 48 hours or more after the initial haemorrhage, the mortality rose to 26.9 per cent. Certainly this mortality far exceeds that following medical management of comparable cases.

Shaw (1936) has drawn attention to an important flaw in G.G. Taylor's argument by pointing out the frequent bleeding from acute ulcers in patients harbouring a chronic peptic ulcer. This introduces a hazard to the surgeon who obviously directs his attention to the removal of the chronic ulcer. Such a formidable

/ procedure

procedure in a patient with haemorrhage carries a much greater mortality than would result from medical therapy the result of which, would in the majority of instances, be complete healing. Schindler (1937), in order to advert this error has recommended gastroscopy in all bleeding ulcers prior to surgery. However, as the duodenum, and a large part of the pylorus and antrum cannot be seen through the gastroscope the chances of seeing the bleeding point are well under 50 per cent. It is, therefore, questionable whether the risk of weakening still further these patients does not constitute a contra-indication to gastroscopy.

In considering the question of performing a partial gastrectomy for acute bleeding, the following factors should be considered:

(a) The age of the patient - It is frequently stated that haemorrhage from a peptic ulcer in a patient under 45 is a medical condition and over 45 a surgical condition. Concerning the former there can be little doubt. This fact was brought home to me by a very impressive case while in the army. The patient, a male aged 29, was bleeding severely from a chronic duodenal ulcer. In spite of all forms of medical therapy he continued to bleed. The co-operation of the surgeons was sought who refused to operate until the bleeding had ceased. Over a period of some four weeks the patient was given one hundred and twenty-nine pints of blood! The haemorrhage had then ceased and a partial gastrectomy was successfully carried

out.

After the age of 45 the decision is not so simple. The mortality from both forms of therapy increases. It is difficult to envisage how haemorrhage from a thickened rigid artery can be arrested by any measure short of resection. Avery Jones (1943) has reported a mortality of slightly under 20 per cent in a group of some 54 patients over the age of 60. It must be admitted that this figure compares favourably with the best results of surgery.

Site of the Lesion

(b) Avery Jones has again drawn attention to this feature. If the patient has been X-Rayed previously and the site of the ulcer is known, the surgeon, with this knowledge, may perform a local resection or partial gastrectomy. The disadvantage as previously pointed out being the possibility of an acute bleeding ulcer in association with the chronic ulcer.

Time since onset of Haemorrhage

(c) G.G. Taylor and other advocates of surgery believe that if the haemorrhage does not cease in the first 48 hours the patient should be given transfusions and prepared for surgery immediately. There can be no doubt that in the past the physician has been responsible for many of the surgical deaths by delivering to the surgeon a moribund patient past middle life who has been bleeding for several days, expecting him to perform a life-saving operation. In patients over 45 with

/ bleeding

bleeding, the surgeon should be consulted as soon as the patient is admitted and throughout therapy the closest liason between surgeon and physician should exist. It is only by such co-operation that the mortality of the later age groups from bleeding ulcer will be reduced.

No patient in the present series was operated on during the period of haemorrhage. This probably reflects the conservatism of therapy in the Edinburgh Royal Infirmary. It should also be borne in mind that this series is based on patients who have survived partial gastrectomy and the operative mortality has not been investigated. It may well be that there were patients operated on during the stage of bleeding who succumbed from the operation. However, we are inclined to believe that the number actually referred to surgery during the bleeding period in this hospital was very small.

Operation Following Asseret of Haemorrhage.

It is a well established fact that an ulcer which has once bled is prone to do so again. Indeed Heuer cites the case of a man who had 58 major haemorrhages. The question then arises as to whether or not every patient who has had a major haemorrhage should be subjected to partial gastrectomy. There are many factors to be considered.

A young person after recovery from a haemorrhage may well be subjected to partial

/ gastrectomy

T A B L E X X I I

PATIENTS OPERATED ON FOR RECURRENT BLEEDING.

No.	NAME	AGE	DURATION OF SYMPTOMS	No. OF MAJOR HAEMORRHAGES	SITE OF LESION	PRE. OP FREE ACID	RESULT
1	SWEENIE	27	6	1	POSTERIOR WALL 1 st PART OF DUODENUM	—	CURE
2	HUNTER	33	16	2	POSTERIOR WALL 1 st PART OF DUODENUM	70	CURE
3	KING	39	6	2	LARGE ULCER ERODING INTO PANCREAS	65	CURE
4	MARSHALL	50	8	4	LESSER CURVATURE OF STOMACH	80	CURE
5	RAEBURN	65	15	1	LESSER CURVATURE OF STOMACH	20	CURE
6	WOOLARD	53	21	3	LARGE ULCER ON LESSER CURVATURE ADHERENT TO PANCREAS	—	FAILURE

- Note. 1. All patients were males.
2. Long pre-operative history of ulcer symptoms (in years).
3. Medical therapy had failed in four patients to prevent recurrence of haemorrhage.
4. Good post-operative results from this indication.

gastrectomy by a competent gastric surgeon in whose hands the mortality should not exceed 5 per cent, whereas a further haemorrhage would carry a risk of a 10 per cent mortality - Table XXII.

Case 1 - Male aged 27 - Six years' history of duodenal ulcer - X-Ray positive - ulcer on posterior wall of duodenum. Severe haematemesis in June 1946 treated by Witts diet and transfusions. July 1946 partial gastrectomy.

Case 2 - Male aged 33 - Sixteen years' history of duodenal ulcer - X-Ray positive. 1939 - severe haematemesis and melaena - six weeks hospitalisation. Put on waiting list for partial gastrectomy. Before admission for partial gastrectomy a second severe haematemesis - four weeks treatment in medical ward then partial gastrectomy.

After 45 the question requires further consideration as was outlined previously. Here one must weigh the risk of a further haematemesis against mortality of partial gastrectomy. In making this decision much will depend on the skill of the surgeon, for, should his mortality rate be under 10 - 15 per cent then there is no doubt that surgery is the correct procedure. The present series includes three such cases.

Case 3. - Male aged 39 - Six years' history of duodenal ulcer - X-Ray positive - ulcer on posterior wall. June 1944 severe haematemesis admitted to medical ward Royal Infirmary, Edinburgh. March 1945 a second severe haematemesis - treated in a medical ward for six weeks then transferred

to surgery for partial gastrectomy.

Case 4. - Male aged 50 - Eight years' history of duodenal ulcer - X-Ray positive. Four admissions to hospital for severe haematemesis and melaena between 1939 and 1945. Six weeks after last admission partial gastrectomy was performed.

Case 5 - Male aged 65 - Fifteen years' history of peptic ulcer - X-Ray showed lesser curvature ulcer. June 1943 severe haematemesis and melaena.

Admitted to medical ward - six weeks treatment prior to partial gastrectomy.

Case 6 - Male aged 53 - Twenty-one years' history of gastric ulcer - X-Ray positive - ulcer on middle of lesser curvature. Between 1925 and 1944 hospitalised three times for haematemesis and melaena. Partial gastrectomy six weeks after arrest of last haemorrhage.

In reviewing these six cases the following points are of interest. All patients were males. All had a long pre-operative history of chronic peptic ulcer average 12.5 years. In three cases the ulcer was duodenal - posterior wall, and in three cases gastric, lesser curvature. All patients had had at least one severe haemorrhage and one had had four. Medical therapy had failed in all six cases to prevent haemorrhage where it was known that an ulcer existed.

In reviewing the merits of medical and surgical therapy for bleeding peptic ulcer, the words of Sir David Wilkie (1938) regarding peptic ulcer are very applicable.

T A B L E XXIII.

RECURRENT PERFORATIONS.								
No.	NAME	AGE	DURATION OF ULCER SYMPTOMS	PERFORATIONS PRE. OP.	PRE. OP. FREE ACID	BLEEDING		RESULTS
						HAEMATEMESIS	MELÆNA	
1.	LEE, MRS.	33	2	2 YEARS 1 YEAR 2 MONTHS	60	0	0	FAILURE
2.	EDMINSON	48	20	15 YEARS 12 YEARS 3 MONTHS	-	0	0	CURE
3.	CUMMING	58	20	7 YEARS 3 YEARS 2 MONTHS	45	0	0	IMPROVED

Note - 1. Absence of bleeding in cases with recurrent perforation.

2. Case I was a woman who had three perforations.

"The idea that physician and surgeon shall be ranged in opposing camps in regard to the treatment of peptic ulcer is contrary to the whole spirit of modern medicine and to the best interests of the patient".

4. RECURRENT PERFORATION - Recurrent perforation was the primary indication for partial gastrectomy in three cases (Table XXIII). In all three instances the patient had had three perforations. In none of the three cases had there been any bleeding thus supporting the old axiom that an ulcer which tends to perforate does not tend to bleed and vice versa.

Case 1 - Female aged 33. Three perforations in the two years immediately prior to partial gastrectomy. It is interesting that this patient was entirely symptom free apart from the pain of the actual perforations.

Case 2 - Male aged 48. Twenty years history of intermittent epigastric pain. Perforations of duodenal ulcer fifteen years, five years and six months prior to partial gastrectomy.

Case 3 - Male aged 58. Twenty years history of intermittent epigastric pain. Perforations of duodenal ulcer, seven years, three years and three months before operation.

In no case was the partial gastrectomy carried out at the time of perforation. Some continental surgeons prefer, in young patients especially, those admitted within a few hours of perforation to perform a partial gastrectomy. Yudin (1937)

of Moscow claimed a mortality of between 5.9 and 11.9 per cent in such good risk cases. Most British surgeons, however, would be unwilling to recommend such a procedure except in rare instances in which it is impossible to close the perforation because of oedema or fibrosis of the ulcer.

In the three cases of recurrent perforation in this series, partial gastrectomy was performed between two and three months after the last perforation with the object of preventing a recurrence. Although the mortality from closure of a perforation is low in a centre such as Edinburgh, it still exceeds that of partial gastrectomy, and consequently this operation was amply justified in all of these cases. The mortality for perforation of 5,061 cases reviewed by Eliason and Ebeling (1934) was 23.9 per cent.

Case 1 in this group is particularly interesting in that this woman had three perforations. Perforated ulcers in women are very rare - Williams and Walsh (1930) found the ratio to be 25 to 1 in 158 instances, while Morrison (1935) found the ratio to be 39 to 1 in 200 instances. Three perforations in a woman is therefore quite unique.

5. - POSSIBLE MALIGNANCY - The possibility of malignant degeneration of peptic ulcer occurs only in cases of gastric ulcer, especially pre-pyloric ulcer. At the beginning of this century several eminent surgeons believed that the incidence of malignant change in benign peptic ulcer was very high. Between 1904 and 1907 Mayo Robson (1903)

Moynihan (1906) and Mayo (1907) stated that in over 50 per cent of cases gastric carcinoma developed from simple peptic ulcer. Moynihan's statement in 1909 to the effect that two out of every three patients upon whom he had operated for gastric carcinoma gave a previous history suggestive of gastric ulcer lent support to the feelings of Mayo Robson and Mayo. Apparent pathological confirmation for these clinical impressions was brought forward in a paper by Wilson and McCarthy (1910) claiming that 71 per cent of 153 gastric carcinomas showed sufficient histopathological evidence of previous peptic ulceration to justify labelling them as cases of gastric carcinomata developing on simple ulcer. However, other pathologists were unable to confirm this high incidence of malignant change in simple ulcer and Ewing (1918) presented figures of 2 to 5 per cent for malignant change. Bertrand (1937) after a very careful investigation, found that 33 of 153 gastric ulcers finally became malignant. Many pathologists experience great difficulty in determining whether or not a given carcinoma has developed from a previously simple ulcer. Hurst and Stewart (1929) found malignant change in 6.1 per cent of 180 cases of chronic gastric ulcer but in only one instance was there evidence that it had developed from a previously simple ulcer.

Crohn (1927) in a review of the literature estimated "ulcer cancer" to occur in 1.2 per cent

of cases. Brown and Sippy (1930) followed up 77 cases of simple gastric ulcer over a fifteen year period and noted that only one patient died of gastric carcinoma. At autopsy the carcinoma was at some distance from the old healed gastric ulcer. From this brief review it is apparent that the possibility of a chronic gastric ulcer becoming malignant is well under 10 per cent.

Considering that 4 per cent of the population between the ages of 40 and 60 will die of gastric carcinoma, chronic gastric ulcer would appear to be less than double the risk of developing a gastric neoplasm.

Gastric Carcinoma Mimicing Chronic Gastric Ulcer.

Although apparently few chronic gastric ulcers undergo malignant change yet not all gastric ulcers, even in their earliest stages, are simple. The fact that what appears to be a simple gastric ulcer may indeed be a gastric carcinoma presenting a typical ulcer picture has only really been appreciated of late. Kirklin (1943) at the Mayo Clinic estimates that the radiological error using the present X-Ray methods is 10 - 14 per cent. Allen and Welsh (1941) found a gastric carcinoma in 14 per cent of 277 cases which clinically and radiologically had been labelled simple ulcer. Anglem (1946) puts the figure at 20 - 25 per cent. Priestley (1943) found the error to be 19 per cent. Clinically the differentiation is not simple. Admittedly, carcinoma usually occurs in older people, has a shorter history and some 30 per cent

have free hydrochloric acid in their test meal. The history may be very similar to that of peptic ulcer. Blackford (1925) noted a history suggestive of simple ulcer in 38 per cent of cases of gastric neoplasm, Eusterman (1926) in 34 per cent and Moynihan (1909) in 66 per cent.

Many pathologists now believe that few ulcers become malignant and that in the great majority of neoplastic gastric ulcers the ulcer has been malignant from the onset. Peptic digestion of the lesion has taken place forming the crater.

As so often happens, the opinion of the radiologist at first examination is equivocal. "Ulcer of the lesser curvature appears simple, but the possibility of malignancy cannot be excluded. Suggest re-X-Ray in four weeks time". During the ensuing four weeks both Jordan (1941) and Eusterman (1944) state that the therapeutic test is only slightly less certain than operation and histological examination. Anglem (1946) disagrees with this, stating that such procrastination is unjustifiable and that even a malignant ulcer will heal to some extent under medical therapy. Gastroscopy might be useful in this differentiation. Assuming that the ulcer is malignant and partial gastrectomy is carried out immediately Allen and Welsh have shown that the cure rate is double that for gastric carcinoma in general.

In considering whether or not to operate in

a case of gastric ulcer, the following facts should be considered. Firstly, there is a maximum 10 - 15 per cent possibility that the lesion is malignant that a further 5 - 10 per cent possibility of its becoming malignant. Therefore, the possibility that the patient has, or will develop, a gastric carcinoma is between 10 and 20 per cent. Secondly, the death rate from partial gastrectomy for benign gastric ulcer in gastric clinics is very low. Jordan and Lahey (1943) 2.7 per cent, Judd and Priestly (1943) 2.5 per cent and Counsellar, Waugh and Claggett (1946) 1.3 per cent. Therefore patients fortunate enough to have surgical therapy in such centres would be well advised to have a partial gastrectomy.

However, as Hinton, (1946) has pointed out the mortality for resection of gastric ulcer in the hands of the "occasional gastric" or "general surgeon" is very high - 20 - 25 per cent. Two factors contribute to this high mortality. The fact that most patients with gastric ulcers are in their fifties or over. More important, however, is the lack of specialisation in gastric surgery by those actually engaged in such work. The mere fact that in Gastric Clinics the mortality is well under 10 per cent, and therefore, much below the probability of malignant disease while in the non specialised centres it is 20 per cent and therefore above the probability of malignant disease would indeed be a plea for specialisation in this field of surgery. Not only

T A B L E XXIV

POSSIBLE MALIGNANCY.								
No	NAME	AGE	DURATION	PRE-OP FREE ACID	BLEEDING		SITE OF LESION	RESULTS
					HAEM.	MELÆNA		
1.	TAYLOR	43	2	20	-	-	PRE-PYLORIC	CURE
2.	WINTON, MRS	52	2	0	-	-	LESSER CURVATURE	FAILURE
3.	LINTON, MRS	47	20	10	-	-	LESSER CURVATURE	IMPROVED
4.	THOMPSON	60	6	-	-	+	PRE-PYLORIC	FAILURE
5.	RICHMOND	43	2	50	-	+	PRE-PYLORIC	CURE
6.	M ^c KENZIE	60	40	20	-	+	LESSER CURVATURE	CURE

Possible Malignancy

1. Average age 51 - 8 years older than series as a whole.
2. Low free acid in pre-operative test meal.
3. Absence of haematemesis.

is specialised training of the surgeon necessary but equally so is the setting up of special units adequately staffed with a team competent in pre and post operative care. Since such surgeons as Lahey have shown that minimal mortalities can be derived from specialisation in this field and Hinton that the converse is the result of non specialisation, surely there can be no doubt as to the future training of those who would wish to embark on a surgical career in this field.

The present series includes six patients operated on because of questionable malignancy of a gastric ulcer (Table XXIV). In all four cases the patient has received previous medical therapy which had failed to give permanent relief of the ulcer symptoms.

The series includes four males and two females ranging from 43 to 60 years of age with an average age of 51 years. The duration of symptoms was short in three instances (Cases 1, 2 and 5) two years, which had led the surgeons to suspect malignancy. In one case (4) the duration of symptoms had been six years and in two cases (3 and 6) twenty and forty years. These latter two cases because of the prolonged history and the evidence of a gastric ulcer which had failed to respond to medical therapy had suggested neoplastic change in the ulcer especially in light of the fact that the free acid in the test meal was very low in both cases - 10 units and 20 units respectively.

Histopathological specimens in all cases relieved a chronic benign gastric ulcer with associated chronic gastritis. The chronic gastritis accounts for the excessive mucus and low free hydrochloric acid which is so often found in cases of chronic gastric ulcer.

6. STOMAL ULCER AND RECURRENT ULCER - The term "Stomal Ulcer" or "Anastomotic Ulcer" applies to any peptic ulcer occurring at or near the site of the suture line, in the stomach, saddling the stoma, or in the jejunum. Recurrent ulcer applies to failure to cure the original gastric or duodenal ulcer or to the development of a new ulcer at one of these sites.

In our present series there were five cases of stomal ulcer and three of recurrent ulcer. All stomal and recurrent ulcers occurred following gastro-enterostomy for duodenal ulcer.

Site of Stomal Ulcer.

Snell (Mayo Clinic 1937) in reviewing this subject found the site of the lesion to occur in the following order of frequency -

- (a) The first 4 cms. of the jejunum:
- (b) The actual stoma itself and
- (c) The afferent loop - the last site being rare.

Of our five cases of stomal ulceration, four occurred in the first 4 cms. of the jejunum and one at the stoma.

Incidence.

Stomal ulcer following gastro-enterostomy

/ was

was first reported by Braun (1899) eighteen years after the first gastro-enterostomy was performed by Wolfler in 1881. Stomal ulcer may develop following any type of operation in which the surgeon utilises as gastro-jejunal anastomosis. Its actual incidence is difficult to determine. Various authors have reported its frequency following gastro-enterostomy as between 1.4 per cent (Walton 1934) and 34 per cent (Lewishom 1925); Hurst and Stewart (1929) believed that Moynihan's figure of 2 per cent was quite erroneous. In one series of autopsies on patients upon whom a gastro-enterostomy had been performed for duodenal ulcer these workers demonstrated jejunal ulcer or scarring in 73 per cent. The Finsterer operation for exclusion is very frequently followed by this complication. Marshall and Devine (1941) reported seven stomal ulcers following thirty four operations of that type. Partial gastrectomy carries a smaller risk of stomal ulcer than any of the other gastro-intestinal anastomotic procedures. Mage (1942) after a very careful follow up of 502 cases found 41 or 8 per cent had developed stomal ulcers. Mateer (1941) also gave the figure as 8 per cent. Lewisohn and Ginzburg (1927) after twelve years experience with partial gastrectomy for peptic ulcer stated they had not seen a single instance of stomal ulcer complicating this procedure.

During this follow up we have encountered two instances of stomal ulcer following partial

/ gastrectomy

STOMAL AND RECURRENT ULCERS

STOMAL ULCER	SITE OF NEW LESION	AGE	DURATION	PERF	GE	TIME BETWEEN ONSET OF SYMPTOMS AND GE	BLEEDING		TEST MEAL PRE - OP
							HAEMATEMESIS	MELAENA	
ORMOND	DU STOMA	44	5	1	2	3 YEARS	+	+	40
FORBES	DU JETUNUM	58	7	2	3	2 YEARS	+	+	-
JACKSON	DU JETUNUM	57	20	15	15	7 YEARS	+	+	46
LAPSLEY	DU JETUNUM	44	16	0	13	2 YEARS	+	+	-
BURTON	DU JETUNUM	55	20	0	8	2 YEARS	+	+	56
<u>RECURRENT ULCER</u>									
AITKEN MRS	GU LESSER CURVATURE	47	10	0	3 MTHS	3 MONTHS	0	0	-
HOUSTON	DU LESSER CURVATURE	44	21	0	10	3 MONTHS	0	0	10
SHARP	DU PRE-PYLORIC	47	18	0	17	10 YEARS	+	+	55

PERF: = Numbers in years of perforations prior to gastro-enterostomy.

GE: = Time of gastro-enterostomy in years after onset of ulcer symptoms.

gastrectomy. They have not been included in the present study because both were admitted when the series was nearing completion, both were referred to surgery and the follow up period was therefore too short to have been of any value. Their histories were very similar. They were males in their early forties, and had had duodenal ulcers which had perforated only to be followed by a recurrence of symptoms for which a gastro-enterostomy was performed. In the first patient this was followed by a stomal ulcer one year later and he was admitted to hospital as a haematemesis. A similar event occurred in the second patient two years after the gastro-enterostomy. Following the haematemesis both patients had a partial gastrectomy. The first man developed another stomal ulcer after three months and the second man after twelve months time.

Age.

The average age of patients with stomal ulcer was 51.25 years. This is rather higher than the figures given by most authors. Judd and Hoerner (1935) found the highest incidence in the third and fourth decades.

Time of Onset.

The average interval between the performing of the gastro-enterostomy and the onset of stomal ulcer symptoms was 3.2 years. In three instances this interval was two years, in one three years, and in one seven years. Allen and Welsh (1946) noted that two thirds of stomal ulcers occurred

/ within

within the first two post-operative years. A longer post-operative interval is not unusual. Lawson (1944) cites an instance of a seventeen year period and in four of twenty one cases the period exceeded ten years.

Haemorrhage.

It is a well recognised fact that stomal ulcers show a marked tendency to bleed and that as Bockus points out in spite of this tendency few patients with stomal ulcer die as the result of haemorrhage. Mage noted bleeding in 18 of his 41 cases, Lawson in 10 of 21 cases. Haemorrhage in the form of haematemesis and melaena was a feature in all five cases. In two of the cases the haemorrhage had been recurrent and patients hospitalised under a medical regime. In the other three cases, the haemorrhage has been a single event. Snell (1937) stated that bleeding may be the only feature of stomal ulcer, occurring as gross haemorrhage in some 25 per cent of his cases.

Pain was a feature in all five cases but differed from the pre-operative pain by being below and to the left of the umbilicus. Mage states that 71 per cent of his patients had pain. Vomiting was a frequent symptom in our series. Four of the five patients complained of this symptom.

Previous Perforation.

Toland and Thompson (1936) drew attention to the frequency with which stomal ulcer patients

gave a history of an earlier perforation. These authors quote the figure of 25 per cent. In our series, three of the five patients gave such a history - one patient having had two perforations. It is not difficult to visualise why this should be so since perforating ulcers usually occur in people with a marked "ulcer diathesis" which no form of surgery can, as yet, remove. When one considers the two cases cited previously where stomal ulcers followed gastro-enterostomy and later partial gastrectomy one realises that there are certain ulcer patients for whom very little can be done. In such people the ulcer tendency seems to be almost a "malignant disease" and irrespective of the therapy adopted the result is the recurrence of the ulcer or the development of a new one.

Free acid in Pre-operative Test Meals.

Unfortunately there are no records for two of the patients. In the three cases with records the free hydrochloric acid was 40, 46 and 56 units which must be considered high following gastro-enterostomy. That this free acid is an essential factor in the production of stomal ulcer is beyond doubt. Lewisohn has never seen stomal ulcer in the absence of free acid. The reduced incidence of stomal ulcer following partial gastrectomy is probably attributable to the more frequent production of achlorhydria by this operation.

The Place of Partial Gastrectomy in the Treatment

of Stomal Ulcer.

Judd and Hoerner have remarked that when a jejunal ulcer is known to exist any one who persists in treating the lesion by medical means for a prolonged period assumes great responsibility because of the serious complications that may develop. The closure of perforations occur in 5.6 per cent (Toland and Thompson 1936), 19 per cent (Wright 1918) and 19 - 23 per cent (Hurst) which carry a mortality of 17.6 per cent (Toland and Thompson). Gastro-jejuno-colic fistula develops in a considerable proportion of cases, 10 per cent has been the figure given by many workers, Eusterman and Balfour (1935), Bolton and Trotter (1920) and Snell (1937).

As Mage points out, stomal ulcer rarely follows gastro-enterostomy for gastric ulcer. He records only one such instance following 98 operations.

Sex.

All cases of stomal ulcer occurred in males. This confirmed the general opinion that stomal ulcer occurs with the same sex incidence as does duodenal ulcer, i.e. six or eight males to each female. Judd and Hoerner (1935) have found the ratio even higher - 12.9 to one.

Recurrent Ulcers Following Gastro-enterostomy

Gastro-enterostomy does not ensure either healing of an ulcer or the prevention of subsequent ulcers developing. There are three such examples in the present series.

Case 1 - Female aged 47. Ten years history of epigastric pain; X-Ray showed ulcer of lesser curvature. Wedge resection and gastro-enterostomy carried out. Three months later recurrence of symptoms. X-Ray showed a second lesser curvature ulcer for which a partial gastrectomy was carried out.

Case 2 - Male aged 44. Twenty one years history of duodenal ulcer. X-Ray positive. 1926 Gastro-enterostomy performed. Pain free until 1939. Recurrence of symptoms January 1946. Pain very severe. X-Ray lesser curvature ulcer - partial gastrectomy February 1946.

Case 3 - Male aged 47. 1929 - Began to have symptoms of duodenal ulcer - X-Ray positive - Gastro-enterostomy performed that year. 1939 recurrence of symptoms - Periods of freedom from pain up to six months. 1946 very severe pain and vomiting - X-Ray showed pre-pyloric ulcer - Partial gastrectomy immediately carried out.

There is one vital factor which influences all the aforementioned indications for partial gastrectomy in peptic ulcer. It is the economic factor. Although a man in secure social surroundings may afford to persist in prolonged medical treatment for his ulcer the bread-winner is not so fortunate, especially as it necessitates his leaving work for two or three months annually. Dr. Gavin Miller (1941) of Montreal lays great stress on this factor as an indication for the operation. The patient in better circumstances

has the advantage of good cooking and can adhere to his diet. The less fortunate patient may have difficulty in acquiring the proper food and his wife has little experience in selecting or preparing a suitable diet.

The surgeon is occasionally inclined to dwell on the failure of medical therapy and to assure the patient that after partial gastrectomy all will be well and further dieting quite unnecessary. This, we are sure, is a grave mistake as has been pointed out by Lahey. In the great majority of cases strict dieting will be unnecessary but he should subscribe to the very moderate type of ulcer diet for the rest of his days.

In rare instances it may be justifiable to perform a partial gastrectomy for a peptic ulcer when the patient is going to some remote area where expert care will not be available in the case of a haematemesis or perforation.

RESULTS OF PARTIAL GASTRECTOMY IN RELATION TO INDICATIONS FOR OPERATIONS

It is only by comparing the results with the various indications that we can judge which patients subjected in the future to this operation will do well and others badly. There are many indications for partial gastrectomy, but not all are attended by the same results; it is therefore pertinent that we examine the results in relation to the various indications.

Since the operative procedure is the same

/irrespective

T A B L E XXV

<u>RESULTS.</u>													
INDICATION	TOTAL No.	CURED		IMPROVED		I.S.Q.		FAILURE		SATISFACTORY		UNSATISFACTORY	
		No	%	No.	%	No.	%	No	%	No	%	No	%
PAIN	41	12	29.26	17	41.44	2	4.89	10	24.39	29	70.70	11	29.28
STENOSIS	11	6	54.53	1	9.09	2	18.18	2	18.18	7	63.62	4	36.36
RECURRENT BLEEDING	6	5	83.33	0		0		1	16.66	5	83.33	1	16.66
RECURRENT PERFORATION	3	1	33.33	1	33.33	-		1	33.33	2	66.66	1	33.33
? MALIGNANCY	6	3	50	1	16.66	-		2	33.33	4	66.66	2	33.33
STOMAL ULCER	8	2	25	1	12½	2	25	3	37½	3	37½	5	62½

Results in Relation to Indications for Partial
Gastrectomy.

Note - 1. Best results with recurrent bleeding
as the indication, 83.33 per cent
satisfactory.

2. Poorest results with stomal ulcer.

irrespective of the indication this factor is a constant and therefore the results if they differ should do so in direct relationship to the indications. (Table XXV).

Intractable Pain, as an indication gave much the same results as the overall group. The percentage of cures was slightly lower but this was compensated by an increase in the percentage of improved cases.

Stenosis. The percentage of cures in this group was higher than the overall average, being 54.53 per cent compared with 38.66 per cent, but the proportion of improved cases was smaller, 9.09 per cent, so that the percentage of satisfactory cases was the same as the overall average. Why cases of stenosis should do well we are not certain but it is a well established fact that judged by results this is also the most satisfactory indication for gastro-enterostomy.

Haemorrhage from Peptic Ulcer. The number of cases in this group is small, but it is interesting that five of the cases were classified as cures, and one as a failure giving a figure of 83.33 per cent as satisfactory cases. Why this indication should be accompanied by such good results is not certain but it may be that the ulcer in these patients is not of such a potent nature as evidenced by the fact that only one of these patients had had a previous perforation. Three of the six cases, however, exhibited free acid in the post operative test meal - in one case 50 units. Therefore the good results in

/ these

these patients would not appear to necessitate post operative achlorhydria. Other workers have also drawn attention to the fact that the late results from the operation when performed for haemorrhage are usually satisfactory.

Taking the thirty-four patients in whom bleeding has occurred at any time whether massive or minimal, the results are better than the average - cures 51.43 per cent and improved 28.61 per cent - giving therefore satisfactory results in 80.01 per cent, is well above the overall percentage of satisfactory results.

Recurrent Perforation. The number of patients in this group is too small to draw conclusions - one was classified as a cure, one as improved and one as satisfactory.

Questionable Malignancy. Again the number in this group is very small - only six cases. However three were labelled cured and one improved. The satisfactory results were, therefore, the same as the overall average. One would have expected somewhat better results following this indication since the operation was performed in all four cases on gastric ulcers. One of the two unsatisfactory cases was due to a severe microcytic post-operative anaemia - Hb. 45 per cent - and the second to severe hypoglycaemia.

Stomal and Recurrent Ulcer. The five stomal and three recurrent ulcers have been included in one group for estimation of results. This group gave the poorest results of the series. Two

/ were

were labelled as cures, one improved, two I.S. and three unsatisfactory. Of the unsatisfactory one had severe hypoglycaemia and continuation of ulcer symptoms. The second was anaemic Hb. 80 per cent had recurrence of peptic ulcer symptoms which to some extent were relieved by alkalis and a milk drip. There was no X-Ray evidence of a stomal ulcer. The third failure was due to severe attacks of hypoglycaemia and severe post-operative loss of weight.

Conclusions. From this short series it would appear that patients who have been operated on for recurrent haemorrhage produce the best results. Intractable pain and stenosis give very similar results and stomal ulcer the poorest results. Recurrent perforation and questionable malignant disease as indications for operation comprise a very small percentage of the present series, and therefore, the results of these indications from a statistical standpoint are of questionable significance. However, it appears that the percentage of success from these two indications would fall somewhere between that of stomal ulcer and intractable pain.

CHAPTER IXPOST OPERATIVE PERIOD PRIOR TO RETURN TO WORK

Of the seventy-five patients in this series fifteen or 20 per cent had not returned to full work; eleven having a post-operative period of more than eighteen months. We feel that any patient who has not returned to full work eighteen months after partial gastrectomy is unlikely to do so later.

Patients who had not returned to full work -

- (a) With a post-operative period less than eighteen months - Four patients fell into this group, all were employed but doing much lighter work than pre-operatively. All complained that because of weakness they were unfit for their previous occupation - manual labour. As these patients had a post-operative period of less than eighteen months it is possible that some may yet be able to return to their former employment.
- (b) Patients with a post operative period of more than eighteen months - Eight of the eleven patients in this group had not returned to their previous occupation because of insufficient energy. The other three had remained in their new employment because of preference for their new occupation.

Patients returning to full work with a post-operative period of less than eighteen months -

Of the sixty patients in this group forty per cent returned to full work in the first three post-operative months, and 35 per cent in the

T A B L E XXVI

POST-OPERATIVE PERIOD IN RELATION TO PATIENTS
RETURNING TO FULL WORK.

POST-OPERATIVE PERIOD IN MONTHS	NUMBER	PERCENT
0 - 3	26	40%
4 - 7	23	35%
8 - 12	10	16.66%
12 - 18	5	8.33%
TOTAL	64	100%

AVERAGE POST-OPERATIVE PERIOD PRIOR TO RETURN TO WORK.

DUODENAL ULCER	4.56 MONTHS
GASTRIC ULCER	6.27 "
STOMAL ULCER	5.1 "
<u>AVERAGE</u>	<u>5.12 "</u>

- Note - 1. 75 per cent of patients returning to full work did so in the first 0 - 7 post-operative months.
2. The average post-operative period prior to return to full work was shortest in the duodenal ulcer group; average 4.56 months; and longest in the gastric ulcer group - average 6.27 months.

second three post-operative months, i.e. 75 per cent in the first six months, (Table XXVI).

The percentage of patients returning to full work showed a progressive decline after the first six post-operative months.

G.G. Taylor et al had 100 per cent of their patients return to full work in the first eighteen months compared with 80 per cent in the present series. These authors, however, do not give details of change of occupation following the operation.

Post-Operative Period in Relation to

1. Site of Lesion - Patients with duodenal ulcer had the shortest post-operative period prior to return to full work, 4.56 months, stomal ulcers 5.12 months and gastric ulcer 6.27 months.

The longer period in the case of gastric ulcer patients we attribute to the fact that these patients were on the average eight years older than those with duodenal ulcer, and therefore required a longer convalescence.

2. End Results - In general the patients who returned to work in the first six months showed the best clinical results, while those who were not at full work twelve months post-operatively were on the whole unsatisfactory.

The latter group, however, contains two patients who were "cures"; both these patients had been given one years post-operative convalescence on pay by their employers.

The post-operative period prior to return to full work parallels the results in general. Patients usually returned to work when they felt capable of earning a livelihood. Patients who had benefitted from the operation resumed employment in the first six months while those less improved by the operation tended to stay off work as long as possible.

CHAPTER XWORKING CAPACITY

The term "working capacity" applies only to the patient's ability to carry out his usual occupation. His ability to fulfil his social obligations and other factors concerning his function as an economic unit are not embraced by this heading.

Working capacity as a measure of post-operative results was used as one of the basic criteria in the attestation of the results in general. However, as it was only one of the criteria employed and as the post-operative working capacity, although closely approximating the end results in any given case is not invariably parallel. For example a patient may be able to perform his work with 100 per cent efficiency yet at the end of the day be so exhausted as to be totally unable to cope with his social and familial duties. Alternately, he may carry on at his employment performing the requisite amount of work in spite of nausea and epigastric discomfort. As these patients were all bread-winners they therefore were apt to reserve their energy for their work, the "working capacity" is consequently therefore the "last ditch" in that when it fails the patient is severely incapacitated by his symptoms. It will be realised that all patients whose working capacity is 100 per cent cannot be labelled "cured".

T A B L E X X V I I

WORKING CAPACITY								
WORKING CAPACITY PERCENTAGE	PRE-OPERATIVE				POST-OPERATIVE			
	MALES		FEMALES		MALES		FEMALES	
	No.	PERCENT.	No.	PERCENT.	No.	PERCENT.	No.	PERCENT.
LESS THAN 50%	39	60.95%	8	72.72%	9	14.05%	6	54.54%
51-75%	9	14.05%	2	18.18%	5	7.82%	1	9.09%
76-100%	16	25.00%	1	9.09%	50	78.13%	4	36.30%
TOTAL	64	100.0%	11	100.0%	64	100.0%	11	100.0%

- Note - 1. Poor pre-operative working capacity.
2. General improvement in working capacity following partial gastrectomy.
3. Improvement in working capacity much more marked in males than females, i.e. 78.13 per cent of males and 36.30 per cent of females in the 76 - 100 per cent working capacity group.

According to the working capacity both pre, and post, operative the patients were divided into three groups (Table XXVII) (a) 0 - 50 per cent; (b) 50 - 75 per cent and (c) 75 - 100 per cent.

PRE-OPERATIVE - The basis of grouping for the pre-operative period was determined by the amount of time lost from work during the two years immediately prior to partial gastrectomy. Time lost due to ulcer symptoms only was considered.

Of the 75 cases 47 or 62.66 per cent fell into group (a). G.G. Taylor et al (1928) state that 77 per cent of their patients were completely incapacitated immediately before the operation. Should we have taken the percentage of our patients in group (a) based only on their immediate pre-operative condition the figure would have been much higher. Peptic ulcer is a disease of such intermittency that the two year pre-operative period gives a much truer picture of their pre-operative working capacity. Analysing group (a) we have found there to be a sex difference of 12.72 per cent, higher in females. Likewise group (c) (working capacity over 75 per cent) shows a much lower percentage of females, 9.09 per cent to 25 per cent.

We conclude that during the two years immediately prior to partial gastrectomy the patient's working capacity was very poor, especially amongst females.

POST OPERATIVE WORKING CAPACITY - This was more difficult to estimate. In many instances the

/ patient

patient did not return to his pre-operative occupation, particularly if it was of an arduous manual nature. In other instances he had returned to his former employment, but because of weakness had sought a more sedentary occupation. G.G. Taylor and his collaborators drew attention to his post-operative loss of energy putting the incidence at 15 per cent. In these cases we have attempted to estimate the post-operative working capacity on the basis of the pre-operative occupation. Such forced change of occupation has often necessitated a change from skilled to unskilled labour and has been accompanied by a corresponding reduction of income. Such a patient who pre-operatively was a miner and is now a night watchman although 100 per cent efficient for his new job, receives only half his pre-operative yearly income and can hardly be labelled a surgical success.

Post operatively only 20 per cent of patients fell into group (a), but again the sex difference was marked, 14.05 per cent of males and 54.54 per cent of females. Group (c) 72 per cent, 78.3 per cent of males and only 36.36 per cent of females. Of the 54 patients making up group (c) forty had a working capacity of 100 per cent.

These results are in agreement with the results in general; namely that males have a much better post-operative result than females. G.G. Taylor et al previously reported this finding. Concerning the post-operative working capacity

/ they

they state that nearly all males and 75 per cent of females were 100 per cent efficient. We have been unable to confirm these remarkable results. The reason for the poor results are discussed under failures. In conclusion we deduce that the post-operative working capacity roughly parallels the results in general. Males recovered their working capacity to a much higher degree than did females.

P A R T I I IC H A P T E R X IPOST-OPERATIVE TEST MEALS

Two test meals were carried in all cases. In the first test one pint of gruel was used as the stimulus. In the second test a similar quantity of gruel was used but in addition 1.00 mg. histamine administered subcutaneously following the withdrawal of the fasting juice.

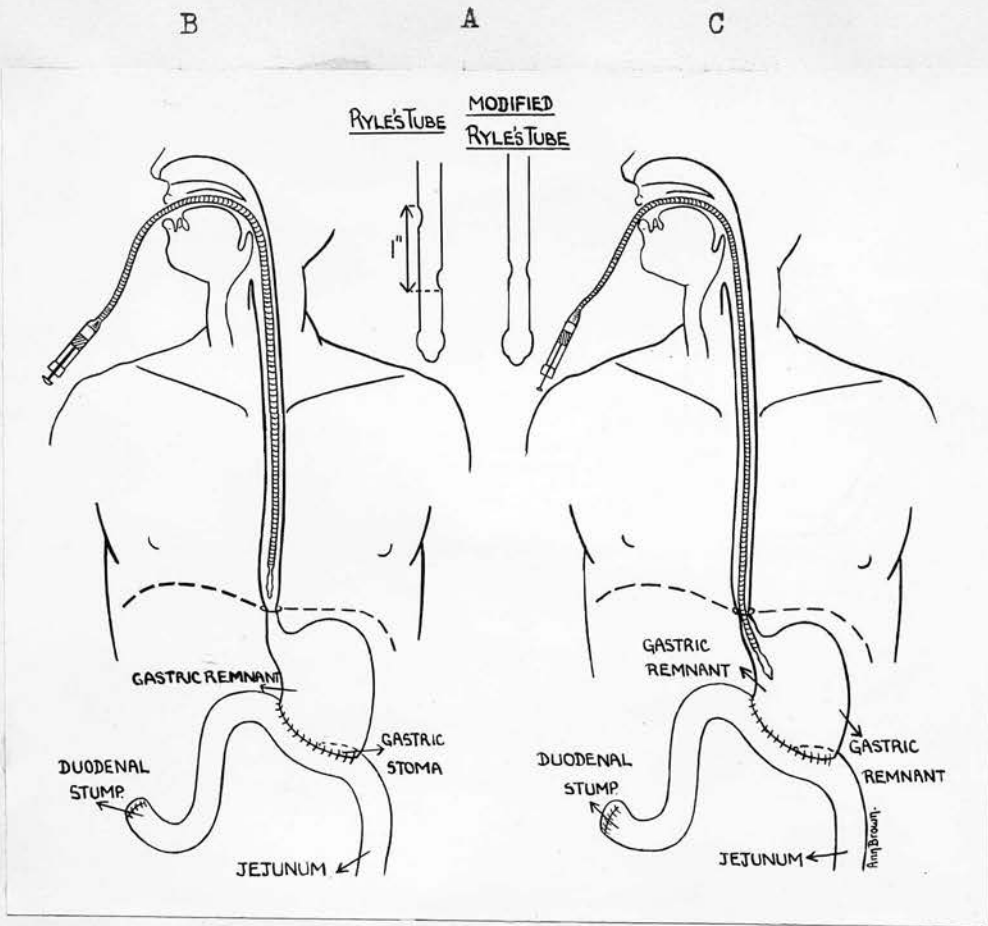
Technique - The patients were given a charcoal biscuit at 10 p.m. on the night prior to the test and subsequently starved until 7 a.m. the following morning at which time the fasting juice was withdrawn and the stomach completely emptied. The test breakfast was then given and specimens of the gastric juice withdrawn at half hourly intervals during the ensuing three hours. The specimens were examined macroscopically for bile charcoal mucous and blood. The free and total acid were estimated by titrating the gastric juice with tenth normal sodium hydroxide using Topfer's reagent as the indicator for free acid and phenolphthalien as the indicator for the total acid. All specimens were then tested for the presence of starch by the iodine test. Finally a quantitative estimation of the pepsin content (vida infra) was carried out.

The following important criteria were observed.

1. All test meals were carried out by the author. Nurses were busy, apt to be disinterested in test meals and prone to neglect certain small but

/ important

DIAGRAM VI



- Note - A. Comparison of Ryle's tube and modification used in these investigations - holes directly opposite in modification.
- B. Tube in oesophagus - air blown down tube by syringe causes audible bubbling so long as holes are above cardia.
- C. Tube passed one and a half inches after bubbling ceased. Position of tube in gastric remnant.

important modifications of the ordinary technique.

2. The stomach was completely emptied before the test was commenced.
3. Dilutions of gastric contents were avoided by having the patient expectorate all saliva during the test.
4. The tests were carried out with the patient in the prone position, thus avoiding as far as possible, the passage of the gastric contents through the stoma.
5. The position of the aspirating tube. It was of utmost importance that the perforations of the aspirating tube be in the gastric remnant and not in the jejunum. This could have been checked radiologically, but as that department was not open at the hour at which the tests were performed, and it would have added an extra burden to an already overworked department the following method of estimating the position of the tube was devised. The tube used was a modification of the ordinary Ryle's tube (Diagram VI). It had two perforations immediately opposite instead of one inch apart, as in the Ryle type. As the tube descended the oesophagus, air blown in from attached syringe escaped through the perforations, thus causing an audible bubbling in the oesophagus so long as the perforations remained above the cardia. The cessation of bubbling indicated that the perforations had passed the cardia, and the tube was then moved on only one and a half inches farther, thus

/ assuring

assuring the presence of the perforations in the gastric remnant. The disadvantage of the Ryle's tube for this type of work is that while the uppermost perforation is still in the oesophagus the lower one is in the gastric remnant, consequently when the tube is advanced a further inch and a half the lower perforation is apt to be in the jejunum.

Many workers have adopted the policy of testing the third specimen of the test meal for free acid. Should this specimen contain no free acid they label the patient as achlorhydric and give histamine to determine whether or not he is truly achylic. This method we believe is apt to be fallacious. We have, in this series, a number of patients who with the ordinary gruel test meal have failed to secrete free acid until the fourth or fifth specimen. Such patients by the standards of other workers would wrongly be called achlorhydric. We believe, therefore, no histamine should be given during the first test. Again some workers in using the histamine test give no stimulus orally. Admittedly such a procedure will give higher figures for free acid, since there is no food to combine with it. Such a test is of great value in establishing the presence or absence of true achylia gastrica. However, from a clinical point of view it has the disadvantage of producing an amount of unbuffered free acid which would never be produced under

/ normal

T A B L E XXVIII

ACHLORHYDRIA			
AUTHORS.	OVERALL GROUP.	SITE OF LESION.	
		GASTRIC ULCER	DUODENAL ULCER
LORENZ AND SCHEPP 1922	75 PERCENT		38 PERCENT
LEWISOHN AND GENZBURG 1927	77 PERCENT	96 PERCENT	67 PERCENT
KLEIN 1927	65 PERCENT	100 PERCENT	60 PERCENT
COMFORT AND OSTERBERG 1931	20 PERCENT		
COMFORT 1934	20 PERCENT		
SNELL 1937	50 PERCENT		
STRAUSS 1937	58 PERCENT		
HOLMAN AND McSWAIN 1943	63 PERCENT	92 PERCENT	50 PERCENT
HEUER 1944	28 PERCENT	72 PERCENT	27 PERCENT
COLP AND DUCKERMAN 1946		95 PERCENT	
BARTELS AND DULIN 1947	73 PERCENT ACHLORHYDRIA AFTER HISTAMINE	90 PERCENT	50 PERCENT
WATSON 1947	85.71 PERCENT HISTAMINE AFTER 4 th SPECIMEN	87.5 PERCENT	83.33 PERCENT

Published figures for achlorhydria following partial gastrectomy for peptic ulceration.

normal conditions. It was for this reason that we used gruel at the same time as histamine in the second test. This produced a state of gastric secretion buffered by food which might take place following the indigestion of food of a high secretogogue value.

POST OPERATIVE TEST MEAL IN GENERAL -

Table XXVIII shows the published figures for achlorhydria following partial gastrectomy. The overall figure of 70.67 per cent for the present series approximates that of most of the other workers whose series contained relatively the same proportion of duodenal and gastric ulcers - i.e. three or four to one. The authors of many of the published series fail to state whether or not a histamine test was used. By using the histamine test meal the percentage of achlorhydric cases in the present series was reduced to 60 per cent. Bartels and Dulin (1947) using the histamine test found the incidence of achlorhydria to be 73 per cent. If the object of the operation is to produce achlorhydria this end is achieved by partial gastrectomy in some 60 - 80 per cent of cases.

Wangansteen (1940) has shown that by giving triple injections of histamine 0.50 mgm. repeated half hourly practically 100 per cent of these patients will secrete free acid. However, as was mentioned earlier, the results of such a test have little clinical application. Patients who failed to secrete free acid in response to

/ gruel

T A B L E XXIX

RESULTS IN RELATION TO FREE ACID (NON-HISTAMINE)

NO FREE ACID	CURED	IMPROVED	I.S.Q	FAILURE	SATISFACTORY	UNSATISFACTORY
DUODENAL ULCER	9	6	1	6	15 68.2%	7 31.8%
GASTRIC ULCER	9	8	1	7	17 68%	8 32%
STOMAL ULCER	2	1	1	2	3 50%	3 50%
<u>LESS THAN 60 UNITS</u>						
DUODENAL ULCER	6	3	3	3	9 60%	6 4%
GASTRIC ULCER	1	1	0	0	2 100%	0 0%
STOMAL ULCER	0	0	1	1	0 0%	2 100%
<u>MORE THAN 60 UNITS</u>						
DUODENAL ULCER	2	1	0	0	3 100%	0 0%
GASTRIC ULCER	0	0	0	0	0 0%	0 0%
STOMAL	0	0	0	0	0 0%	0 0%
TOTAL	29	20	7	19	49	26

Actual distribution of patients in this series according to site of lesion, post-operative acid grouping and end result.

T A B L E XXX

RELATIONSHIP OF PRE AND POST-OPERATION ACID

PRE-OPERATION		POST-OPERATION		
GROUP		ACHLORHYDRIA	LESS THAN 60	MORE THAN 60
A	0-30	85.7 PERCENT	14.3 PERCENT	—
B	30-60	63.63 PERCENT	27.27 PERCENT	9.09 PERCENT
C	60+	50.00 PERCENT	41.66 PERCENT	8.33 PERCENT

Heuer's grouping according to free acid

Note - Parallel between groups A, B, and C on a pre- and post operative acid basis.

Group A - 14.3 per cent with free acid post-operatively.

B - 36.36 per cent " " " "

C - 50 per cent " " " "

gruel and 1 mgm. of histamine were assumed to be achylic.

We have followed the principle of Heuer (1944) in classifying the cases according to the amount of free hydrochloric acid in their post-operative test meals. This classification divides the cases into three groups - those with no free acid; those with free acid but less than 60 units; those with free acid of 60 units and over. Table XXIX shows the actual distribution of cases according to the site of the lesion, the post-operative acid grouping and the end result.

THE COMPARISON OF PRE AND POST OPERATIVE ACIDITIES -

Based on Heuer's grouping the pre-operative acidities are shown in Table XXX. In comparing these three groups following partial gastrectomy it was found that there was a close parallel with the pre-operating groupings on an acid basis. Post operative achlorhydria was present in 85.7 per cent of Group A, 63.63 per cent of Group B, and only 50 per cent of Group C. It is also of interest that in Group A there were no instances of a post-operative acid of more than 60 units.

RESULTS IN RELATION TO POST OPERATIVE ACIDITY -

Table XXXI shows actual distribution of cases and the post-operative acidities in relation to the results. We have been unable to find any correlation between the end results of partial gastrectomy and the presence or absence of free acid in the post operative test meal. 69.6 per

/ cent

RESULTS IN RELATION TO FREE ACID

	NO FREE ACID		LESS THAN 60		60+	
	No	PERCENT	No	PERCENT	No	PERCENT
	CURED 29	20	69.6%	7	24.5%	2
IMPROVED 20	15	75.0%	4	20.0%	1	5.0%
I.S.Q 7	3	42.8%	4	57.2%	0	0
FAILURES 19	15	78.4%	4	21.6%	0	0

Non Histamine Test Meal.

Note - No correlation between post-operative achlorhydria and end results.

71.5 per cent of satisfactory cases - achlorhydric
 69 per cent of unsatisfactory cases - achlorhydric

POST OPERATION ACID IN RELATION TO RESULTS

	No	CURED		IMPROVED		I.S.Q		FAILURE		SATISFACTORY		UNSATISFACTORY	
		No	%	No	%	No	%	No	%	No	%	No	%
		ACHLORHYDRIA	53	20	37.73	15	28.3	3	5.66	15	28.3	35	66.02
LESS THAN 60 UNITS	19	7	36.84	4	21.05	4	21.05	4	21.05	11	57.89	8	42.1
MORE THAN 60 UNITS	3	2	66.66	1	33.33	0	0	0	0	3	100	0	0

Appraisal of results based on post-operative acid grouping only.

The achlorhydric were more satisfactory by 66.02 per cent to 57.89 per cent, i.e. 8.13 per cent only. The three patients with more than 60 units of free acid were all satisfactory.

Conclusion from Tables XXXI and XXXII - Using the non histamine test there is no relationship between post-operative acidity and post-operative results.

cent of the "cures" were achlorhydric compared with 78.4 per cent of the "failures". Using the classification of "satisfactory" cases as applying to "cured" and "improved" patients and "unsatisfactory" as applying to "in statu quo" and "failures" the results are very similar. Of the "satisfactory" cases 71.5 per cent were achlorhydric compared with 69 per cent of the "unsatisfactory". It is of some interest that the three patients with post-operative acidities of over 60 units of free acid were all amongst the "satisfactory" cases.

POST OPERATIVE ACIDITY IN RELATION TO RESULTS -

Again if we appraise the results only from the viewpoint of post-operative acidity and disregard all other factors, table XXXII, we find no difference in the cure rate in the "achlorhydria", and the "less than 60 units" of free acid groups. Using the classification of "satisfactory" and "unsatisfactory" results the achlorhydric groups were better by 8.13 per cent. This suggests that the results from operations producing achlorhydria are slightly superior to those which leave the stomach capable of secreting less than 60 units of free acid. Heuer claims very similar results.

The group with more than 60 units of free acid contains only three cases and is therefore, too small to be of any statistical significance; however, all cases in this group were "satisfactory". If we divided the cases in two groups only according to whether or not they were achlorhydric the

T A B L E X X X I I I

RESULTS BASED ON HISTAMINE TEST						
	NO FREE ACID		LESS THAN 60 UNITS FREE ACID		MORE THAN 60 UNITS FREE ACID	
	NO	PERCENT	NO	PERCENT	NO	PERCENT
CURED	17	37.77	7	36.8	5	45.45
IMPROVED	12	26.66	5	26.31	3	27.27
I.S.Q	3	6.66	3	15.78	1	9.09
FAILURES	13	28.88	4	21.06	2	18.18
ACHLORHYDRIA WITH FREE ACID			SATISFACTORY 64% SATISFACTORY 66.66%			

Based on the histamine test meal there was no relationship between the post-operative acid and the post-operative result.

percentage of "satisfactory" results are almost identical, 66.07 per cent for the achlorhydric and 63.7 per cent for those with free acid. These figures were all based on the non-histamine test meal.

Figures based on the results of the histamine test meal, table XXXIII, show almost precisely the same results 64 per cent "satisfactory" results in the achlorhydric group compared with 66.66 per cent in the group with free acid. We conclude that the "satisfactory" and "unsatisfactory" groups of patients contain approximately the same percentage of achlorhydric patients. Taking the results of the post-operative test meals histamine and non-histamine as the basis, the results are the same for the achlorhydric group and the group having free acid. These findings support the views of Lewisohn and Ginzburg (1927), Heuer and Holman (1943) and Strauss (1937) who demonstrated that "satisfactory" results from gastric resection do not parallel the post-operative gastric acidity. In light of this finding it would seem unjustifiable to carry out major resections of the stomach with the higher mortality in hope of producing post-operative achlorhydria which is probably of doubtful benefit. It should be borne in mind, however, that the patient with post-operative free acid, especially if high, runs the risk of stomal ulcer; a danger from which the achlorhydric patient is free. Lewisohn reporting the results of a large series of cases stated that he had

T A B L E X X X I V

(a)

POST OPERATIVE ACIDITY
NON HISTAMINE TEST.

	ACHLORHYDRIA		FREE ACID			
			LESS THAN 60 UNITS		MORE THAN 60 UNITS	
	NO.	PERCENT	NO.	PERCENT	NO.	PERCENT
DUODENAL ULCER						
PRIMARY	14	56%	9	36%	2	8%
SECONDARY	8	53.33%	6	40%	1	6.66%
TOTAL	22	55%	15	37.5%	3	7.5%
GASTRIC ULCER	25	92.5%	2	7.5%		—
STOMAL ULCER	6	75%	2	25%		—
TOTAL	53	70.6%	19	25.33%	3	4%

Non Histamine Test Meal.

- Note -
1. Lowest percentage of post-operative achlorhydria was in primary duodenal ulcer group, 53.33 per cent.
 2. Highest percentage in gastric ulcer group, 92.5 per cent.
 3. No cases of "more than 60 units" of free acid in the gastric or stomal ulcer groups.
 4. 70.6 per cent of series, achlorhydric

(b)

POST-OPERATIVE ACIDITY
HISTAMINE TEST

	ACHLORHYDRIA		FREE ACID			
			LESS THAN 60 UNITS		MORE THAN 60 UNITS	
	NO.	PERCENT	NO.	PERCENT	NO.	PERCENT
DUODENAL ULCER						
PRIMARY	10	40%	8	32%	7	28%
SECONDARY	6	40%	5	33.33%	4	26.66%
TOTAL	16	40%	13	32.5%	11	27.5%
GASTRIC ULCER	23	85.55%	4	14.44%		—
STOMAL ULCER	6	75%	2	25%		—
TOTAL	45	60%	19	25.33%	11	14.66%

Histamine Test Meal

Similar figures to (a) but incidence of achlorhydria about 10 per cent less.

never seen a stomal ulcer develop in the absence of free hydrochloric acid.

POST OPERATIVE ACID IN RELATION TO SITE OF LESION -

Non-histamine test meal, table XXXIV, shows the results of the post-operative non-histamine test meal according to the site of the initial lesion. The results in general are comparable to to majority of published results.

Duodenal Ulcer - Taking primary and secondary duodenal ulcer as a group 55 per cent were achlorhydric. This figure is again about the average of the results published by other workers. The division of duodenal ulcers into primary and secondary groups has made little difference to the incidence of achlorhydria - 56 per cent in the primary cases and 53.33 per cent in the secondary cases. It is difficult, therefore, to confirm the feelings of some workers who believe that the somewhat poorer results in the secondary group is due to a lower percentage of achlorhydric cases. Friedall, Shaar and Walters (1942) gave a figure of 50 per cent achlorhydria for secondary cases, a figure almost identical with that of the present series.

Watson's figure of 83.33 per cent achlorhydria for duodenal ulcer cases is indeed a remarkable figure. This author, using the gruel test meal, gave histamine after the fourth specimen if it contained no free acid. Since he took specimens at 15 minute intervals he was stating a person was achlorhydric if they secreted no acid at the

end of one hour. This as we have noted previously is, in a considerable percentage of cases, fallacious.

Gastric Ulcer - This group of patients exhibited a very high percentage of post-operative achlorhydria, 92.5 per cent. This figure is again concurrent with the findings of other workers.

Stomal Ulcer - Achlorhydria of 70 per cent for this group was intermediate between that of duodenal and gastric ulcer.

Histamine Test Meal - Achlorhydria, or rather achylia based on the histamine test meal was reduced by 10 per cent. Eight patients who have been achlorhydria to the gruel test meal showed free acid with the histamine test meal. Of the eight patients six were cases of duodenal ulcer and two of gastric ulcer. Consequently the fall in percentage of achlorhydric cases was more marked in the duodenal than in the gastric ulcer group, i.e. 55 per cent to 40 per cent to 92.5 per cent to 85.55 per cent. This reduction was the same in the secondary as in the primary duodenal groups.

Discussion - Why, by the same operative procedure, resection for gastric ulcer should result in a much higher percentage of achlorhydric and achylic cases than resection for duodenal ulcer has long been a topic of speculation. Many hypothesis have been advanced.

1. Cases of gastric ulcer have a much lower pre-operative acid than duodenal cases. Consequently the removal of the same amount of acid secreting

/ tissue

T A B L E X X X V

AVERAGES			
	NON HISTAMINE TEST MEAL		
	PRE-OPERATION ACID	POST-OPERATION ACID	REDUCTION IN FREE ACID
DUODENAL			
PRIMARY	68 UNITS	20 UNITS	48 UNITS
SECONDARY	67 UNITS	27 UNITS	40 UNITS
AVERAGE FOR DUODENAL	67.3 UNITS	24 UNITS	43.3 UNITS
GASTRIC	51 UNITS	18.2 UNITS	33 UNITS
STOMAL	37.5 UNITS	5 UNITS	32.5 UNITS
AVERAGE FOR SERIES	58.8 UNITS	15 UNITS	43.8 UNITS

Comparison of Pre and Post-operative Acidities

- Note - 1. Highest pre-operative acid in duodenal ulcer group - average 67.3 units.
2. Highest post-operative acid in duodenal ulcer group - average 24 units.
3. Reduction in free acid greatest in duodenal ulcer group - average 43.3 units.

tissue will produce a lower post-operative acid level in cases of gastric ulcer Table XXXV. The cause of the lower pre-operative acid in cases of gastric ulcer are due to several factors. These patients were on the average older than the patients with duodenal ulcer by eight years. The presence of a gastric ulcer causes a local gastritis and therefore less free acid. The gastric or second phase of secretion is the dominant phase in gastric ulcer. This phase is removed by partial gastrectomy. The first or psychic phase, as shown by Dragstedt (1947) is the dominant phase in cases of duodenal ulcer and is not affected by partial gastrectomy.

2. Klien (1927) quoting the experimental work of Lim Ivy and McCarthy (1925) held that there are inhibitory fibres in the first part of the duodenum. Removal of these inhibitory fibres occurs more frequently in operations for duodenal than for gastric ulcer.

3. In gastric ulcers of the lesser curvature the incision has often to be carried much higher in order to remove the ulcer. This sacrifice of a greater extent of the lesser curvature and the hypothetical nodal centre of Keith which controls secretion accounts for the greater incidence of achlorhydria in this group.

We believe that the first factor is probably the most important one.

In light of the recent work on the hormone enterogastrone which is formed in the duodenum

T A B L E X X X V I

AVERAGE ACIDS WITH AGE GROUPS

AGE	ACHLORHYDRIA		LESS THAN 60 UNITS		60 +	
	NO.	PERCENT	NO.	PERCENT	NO.	PERCENT
20-39	6	35.33%	10	58.88%	1	5.88%
40-49	20	71.43%	8	28.57%	0	0%
50-59	21	91.00%	0	0%	2	9.00%
60+	6	83.34%	1	16.66%	0	0%
	53		19		3	

Note - Parallel between percentage of
 achlorhydric cases and increase in
 age.

and the administration of which has beneficial effects in cases of peptic ulcer - Hubacher 1946 - we believe that by removing more of the duodenum we are removing more of the enterogastrone secreting tissue. This rather than the removal of the inhibitory fibres of Lim, Ivy and McCarthy would seem to be a more rational basis of why achlorhydria more often follows resection for gastric ulcer with minimal removal of the duodenum than duodenal ulcer in which a large part of the duodenum is necessarily sacrificed in order to completely extirpate the ulcer. A further factor is the loss of the alkaline secretions of the duodenum which accompanies the more radical excision for duodenal ulcer.

THE RELATION OF POST OPERATIVE ACIDITY TO AGE -

In general the post operative acidity showed a decline with the progression of age, table XXXVI. In the 20 - 39 age group the percentage of achlorhydric cases was only 35.53 per cent. This percentage increased steadily to 91 per cent in the 50 - 59 age group. The figure of 83.34 per cent achlorhydria in the "60 and over" age group was lower than the progressive increase with age would have predicted. This later group consists of only seven patients, one of whom had free acid, this single incidence makes the figure of doubtful significance. The table "in toto", however, strongly suggests that the incidence of post-operative achlorhydria increases with age.

T A B L E X X X V I I

POST-OPERATION ACIDS WITH POST-OPERATION PERIOD				
POST-OPERATIVE PERIOD	ACHLORHYDIC	AVERAGE PRE-OPERATIVE ACID	POST-OPERATIVE NON HISTAMINE	AVERAGE FOR GROUP
0-2 YEARS	70 PERCENT	63.8 UNITS	50.2 UNITS	15
2-5 YEARS	75 PERCENT	53.33 UNITS	25.0 UNITS	5
5+ YEARS	80 PERCENT	61.5 UNITS	40.0 UNITS	8

Note - Increase in percentage of achlorhydric cases parallels increase in post-operative period.

RELATION OF POST-OPERATIVE ACIDITY TO POST-OPERATIVE PERIOD -

It may be said that in general the percentage of achlorhydric cases increases in direct proportion to the post-operative period (Table XXXVII). A 70 per cent incidence of achlorhydria in the 0 - 2 year post-operative period increased to 80 per cent in the over five year period. In interpreting such figures it is important to remember, as St. John (1939) points out, that these tests were all performed at one period only in the post-operative lives of these patients. It would be of great value to know whether or not these percentages of achlorhydria for the various post-operative time groups were the same for the individuals making up these groups immediately after the operation, or whether the percentage of achlorhydric cases actually increased with the post-operative period. Such information can only be gained by the follow up in continuity as suggested by St. John. The work of Wangansteen (1940) suggests that a certain percentage of patients with free acid immediately after partial gastrectomy will in time develop achlorhydria.

FREE ACID IN POST-OPERATIVE FASTING JUICE -

Friedall et al have laid stress on the significance of free acid in the fasting juice following partial gastrectomy. These authors noted all such patients exhibited high concentrations of free acid in the later specimens of the test meal. In the present series all

three cases with a free acid over 60 units in the non histamine test and ten of the eleven in histamine test had free acid in the fasting juice. It is of great significance that these were the only ten cases in the series with free acid in the fasting juice. Such a finding is, we believe, the most significant in the whole of the test meal. Any patient with free acid in his fasting juice is certain to produce a marked response to histamine.

All eleven were patients who had been operated on for duodenal ulcer. It is generally implied, especially by the work of Dragstedt that gastric secretion via vagal stimulation is excessive in patients with duodenal ulceration. Our findings would support the work of Dragstedt and imply that partial gastrectomy although relieving the pain of duodenal ulcer does not remove his ulcer diathesis which continues after operation to manifest itself by vagal stimulation producing free acid in the fasting juice. Dragstedt by vagotomy has reduced the fasting acidity to zero in many such cases.

T A B L E X X X V I I I

PEPSIN INTERPRETATION OF RESULTS			KLEINER 1945
CLOT TIME	TENTATIVE COMPARISON WITH NORMAL	APPROX NO OF UNITS/cc GASTRIC JUICE	SUGGESTED METHOD OF REPORTING
LESS THAN 3	VERY HIGH	OVER 2,500	+ + + +
3 - 4	MODERATELY HIGH	2,001 - 2,500	+ + +
4 - 10	USUAL NORMAL	1,001 - 2,000	+ +
10 - 15	LOW	501 - 1,000	+
OVER 15	NONE TO TRACE	0 - 500	0 OR TRACE

Interpretation of Pepsin Levels.

C H A P T E R XIIPEPSIN CONTENT OF GASTRIC JUICE

Pepsin estimation had not been carried out pre-operatively in this series. The post-operative study includes pepsin estimation on all test meal specimens of all patients. The method of pepsin estimation used was that of Barowasky, Tauber and Kleiner (1937). This method of pepsin estimation is based on the property of pepsin to clot milk at p_H. 5 and is only applicable in adult cases whose gastric juice has no rennin activity. The length of clotting time varies inversely with the amount of pepsin, so that under standard conditions a knowledge of clotting time will indicate the concentration of pepsin. A unit is defined as the amount of milk which will clot 1 cc. of milk solution (prepared by adding equal quantities of milk and a sodium acetate buffer solution of p_H. 5) at 20°C. in ten minutes. In a more recent article Kleiner (1945) Table XXXVIII gave the relative values of the pepsin content. Barowasky et al found that in general the pepsin content paralleled the free hydrochloric acid and a normal pepsin value was between 1000 and 2000 units; 2000 units corresponding with a free hydrochloric acid content of about 40 units. Vanzant and her collaborators using a modification of the Cowgill and Gilman method of pepsin estimation noted abnormally high values in 50 per cent of patients with duodenal ulcer.

Apart from a statement by Lewisohn and

/Ginzburg

T A B L E X X X I X

PEPSIN IN RELATION TO SITE OF LESION

SITE OF LESION	0 UNITS		1-2000 UNITS		2000+ UNITS	
	No.	PERCENT.	No.	PERCENT.	No.	PERCENT.
DUODENAL	3	6.66 %	23	51.11%	19	42.22%
GASTRIC	10	37.04%	15	55.55%	2	7.41%
STOMAL	2	25. %	5	62.5%	1	12.5 %

Note - The duodenal ulcer group had the highest post-operative pepsin values, 42.22 per cent with more than 2000 units, compared with 7.41 per cent of the gastric ulcer group.

Ginzburg (1927) we have found no other reference to the pepsin content of gastric juice following resection for peptic ulcer. These authors who studied twenty one cases found pepsin to be absent in 35 per cent, diminished in 50 per cent and normal in 15 per cent. They give no details as to the procedure used in these determinations.

PEPSIN IN RELATION TO SITE OF ULCER -

The results of the pepsin estimations based on the original sites of the lesions is shown in Table XXXIX. The percentage of patients rendered pepsin free by partial gastrectomy, parallels that of post-operative achlorhydria in that the lowest percentage occurred in the duodenal ulcer group at 6.66 per cent, the highest in the gastric ulcer group at 37.04 per cent with the stomal ulcer group midway between at 25 per cent. The average for the series being 20 per cent. By far the highest percentage of patients with pepsin values of over 2000 occurred in the duodenal group, 42.22 per cent compared with 7.41 and 12.5 per cents respectively for gastric and stomal ulcer groups.

RELATION TO PEPSIN TO FREE ACID -

Whereas fifty three patients were achlorhydric only fifteen had no pepsin in their test meals. This means that thirty eight achlorhydric patients had pepsin. In general the amount of pepsin corresponded closely with the free acid. None of the twenty two cases of pepsin over 2000 units occurred in achlorhydric patients.

T A B L E X L

PEPSIN IN RELATION TO RESULTS.

	CURED	IMPROVED	I.S.Q.	FAILURES	SATISFACTORY	UNSATISFACTORY
	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
NO PEPSIN	11.76%	17.63%	11.76%	58.82%	29.39%	70.61%
0-2000 UNITS	57.57%	18.18%	6.06%	18.18%	75.75%	24.24%
2000+ UNITS	40.91%	31.31%	13.67%	13.67%	72.22%	27.78%

Note - The greater percentage of satisfactory results in patients with pepsin in their post-operative gastric juice (75 per cent) compared with those with no pepsin (29 per cent).

There was no increase in pepsin following the giving of histamine, nor was there a single instance in which histamine provoked the secretion of pepsin when it had not already been present in the non-histamine test. This finding in the intact stomach has often been referred to by Babkin (1944) who believes that histamine and gastrin are not identical. Gastrin stimulating the chief and parietal cells and histamine the parietal cells only. It would therefore appear that the ability of the stomach to secrete pepsin is retained longer than the ability to secrete free hydrochloric acid. This supports the findings of Barowasky et al who demonstrated pepsin in the gastric juice of achlorhydric patients.

RELATION OF RESULTS TO AMOUNT OF PEPSIN - Table XL.

There was a much higher percentage of satisfactory results in patients with pepsin than those without. This statement holds for both groups of patients with pepsin, there being practically no difference in the percentage of satisfactory results for the 0 - 2000 unit and 2000 and over groups, i.e. 75 per cent. However, the patients showing no pepsin had only 29.39 per cent satisfactory results.

From these findings we conclude that the presence rather than the absence of pepsin in the post-operative test is more often associated with successful results. Also that twenty two

/ patients

patients of whom nineteen followed resection for duodenal ulcer continued after gastric resection to secrete pepsin in concentrations above the upper limit of normal (2000 units Kleiner).

POST OPERATIVE EMPTYING TIME OF STOMACH

The emptying time of the normal intact stomach varies between three and a half and four and a half hours. Since partial gastrectomy of the Polya and Hoffmeister techniques produce dependent drainage of the gastric remnant, it follows that the period of gastric evacuation should be reduced by this procedure. We have derived the emptying time of our cases by testing for starch in the various specimens of the test meals. In addition we have checked the period of gastric evacuation by X-Ray screening in fifteen cases and obtained results very similar to those of the simple starch test.

The average period for gastric evacuation in this series was 90 minutes with extremes of less than 15 minutes and more than 150 minutes. These findings are similar to those of Gorvett and Taylor (1937) in whose series 77 per cent of patients had an evacuation period of less than 145 minutes; G.G. Taylor et al (1928) 79 per cent in less than 75 minutes, and Strauss et al (1938) who found the average emptying time of their series to be 92 minutes.

RELATION OF EMPTYING TIME TO END RESULTS -

On the basis of the end results there was little difference in the period of gastric evacuation. Admittedly the "cures" had the

/longest

T A B L E X L I

(a)

EMPTYING TIME IN RELATION TO RESULTS			
	MINIMUM	MAXIMUM	MEAN
CURES	0'	150'	80'
IMPROVED	30'	150'	62'
I.S.Q.	5'	150'	70'
FAILURES	0'	150'	66'

} SATISFACTORY 70.

} UNSATISFACTORY 67.

EMPTYING TIME IN RELATION TO RESULTS								
TIME IN MINS.	CURES		IMPROVED		I.S.Q.		FAILURES	
	NO.	PERCENTAGE	NO.	PERCENTAGE	NO.	PERCENTAGE	NO.	PERCENTAGE
0-60	9	31.04	4	20.	2	28.57	3	15.79
60-120	12	41.38	14	70.	5	71.43	13	68.42
120 +	8	27.58	2	10.	0	0.	3	15.79

- Note - 1. Average emptying time longest in cures, i.e. 80 minutes.
2. The greatest percentage of all results occur in the 60-120 minute group.

(b)

RESULTS IN RELATION TO EMPTYING TIME							
		0-60 MINUTES		60-120 MINUTES		120+ MINUTES	
		NO.	PERCENTAGE	NO.	PERCENTAGE	NO.	PERCENTAGE
CURED	29	9	50.00	12	28.64	8	61.53
IMPROVED	20	4	22.22	14	31.81	2	15.40
I.S.Q.	7	2	11.11	5	11.36	0	0
FAILURES	19	3	16.66	13	28.19	3	23.07
SATISFACTORY	49	13	72.22	26	60.45	10	76.93
UNSATISFACTORY	16	5	37.77	18	39.55	3	23.07

Comparable figures are given by all three groups when results are based on the gastric emptying time.

longest period by 10 minutes on the average. However, classifying the cases as "satisfactory" and "unsatisfactory" there was no difference. In considering these figures it is to be remembered that they are taken on specimens withdrawn at half hourly intervals and consequently are a rough guide only.

Basing the results on the period of gastric evacuation table XLI where the cases having been divided into three groups - less than 60 minutes; between 60 and 120 minutes; and more than 120 minutes - using the classification of "satisfactory" and "unsatisfactory" results, there was practically no difference, the best results by 4 per cent being in the over-120 minute group. We conclude from these figures that there is no significant difference in the end results of partial gastrectomy when based on the period of gastric evacuation, a conclusion contradictory to that of Strauss et al, who held that there was singly better results with a prolonged period of emptying. The majority of the "unsatisfactory" results associated with a very rapid gastric evacuation in our series have been due to hypoglycaemia, a subject which will be dealt with in Chapter XV.

C H A P T E R X I V
POST PRANDIAL DISTENSION

The post-prandial distress experienced by some gastrectomised patients follows a fairly typical pattern. Even while the patient is still at his meal, and although his appetite may not be assuaged, a marked sensation of epigastric pressure, distension and fullness develops, that prevents him from taking another morsel. Nausea and even vomiting may accompany these symptoms. The milder symptoms were noted in twenty of our cases (post-operative period more than six months), and the more severe symptoms, those accompanied by vomiting in three (post-operative period six to twelve months). It is of importance to note that these symptoms came on during the meal, whereas those of the "dumping syndrome", which is discussed in the next chapter, occurred between a half and one hour after the meal.

The incidence of the post-cibal syndrome has been reported to be in the region of 10 per cent although reports vary, Church and Hinton (1942), G.G. Taylor et al (1929) and Strauss et al (1937). A rather dark picture is drawn by Jordan (1941) who found that abdominal symptoms occurred post-operatively in thirteen of twenty patients operated on for severe duodenal ulcer, eighteen of forty-one operated on for bleeding ulcer, and eight of twelve operated on for stomal ulcer. This series however, includes ulcer recurrences and other

/ complications

complications. In discussing Jordan's paper Mateer (1941) stated that after subtotal gastrectomy 14 per cent of his patients suffered from mild, and 4 per cent from severe symptoms that could not be ascribed to ulcer recurrences. Of Browne and McHardy's (1943) thirty patients sixteen complained of dyspepsia. On the other hand only four of the seventy-four patients followed by Vitkin (1940) had epigastric complaints. These authors, however, do not differentiate post prandial distension from the "dumping syndrome" and their figures must be accepted as inclusive of both conditions.

The actual incidence of post prandial distension is difficult to compute. In the first few months after the operation the disorder is quite prevalent in its milder form - 50 per cent in the present series. This figure applies only to the taking of normal sized meals - with smaller meals the frequency was correspondingly less.

PHYSIOLOGICAL BASIS OF POST PRANDIAL DISTENSION -

In the average patient who makes a good recovery from a partial gastrectomy, X-Ray examination of the gastric remnant shows that this may be somewhat atonic in the early post operative period but subsequently it becomes small, appears to exhibit a high degree of tone and is often without a gas bubble, Santy and Mallet-Guy (1939), Vitkin (1940). In time, however, the capacity of the gastric stump increases, a process which is effected by elongation of the greater curvature, the gas bubble reappears and the

stomach again assumes some of its reservoir functions. The partially resected stomach sometimes exhibits peristaltic waves, Vitkin. In other cases as Strauss and his colleagues have shown the general motility tends to be deranged. Schlinder (1940) believed that the stoma took on a sphincter like action - a theory strongly contested by Vitkin.

Unfortunately the adjustments of the alimentary canal to subtotal gastrectomy do not proceed smoothly in all patients. Irregular or delayed emptying of the gastric stump may be marked, particularly in the earlier post-operative period.

We believe that the cause of the mild post prandial distension in the early post-operative period to be due to the fact that the patient is attempting to put into his small gastric remnant the same quantity of food that he ingested pre-operatively. The basis of his symptoms are those of simple distension which usually improve with time, concomittant with the increase in size of the gastric remnant.

Other workers, however, do not subscribe to such a simple basis for the symptoms; Ravdin (1943) and his associates believed the basis to be partial occlusion of the stoma from oedema the result of hypoproteinaemia. Hypoproteinaemia, as shown by Leigh (1942) and Ariel, Abels, Pack and Rhoads (1943) can certainly influence the motility of the alimentary tract. Other factors

are at work as was shown by Chauncey and Gray (1943). We have been unable to correlate the plasma protein level and the presence of post prandial distension in the twenty patients with mild distension six months or more after operation. The plasma protein level in this group being average 6.3 gm. per cent while for the patients not suffering from this symptom it was 6.32 gm. per cent.

In all three patients with severe post prandial distension accompanied by vomiting the post-operative period was less than six months; their plasma protein levels were 5.02 gm. per cent, 5.20 gm. per cent and 6 gm. per cent. We have attributed these lower readings to the fact that these patients have deficit intake of protein from vomiting and not that the lowered plasma proteins were causing oedema of the stoma. The plasma protein levels of these patients were all above the critical level for oedema - Total protein 4.5 gm. per cent; Albumin 2.5 gm. per cent.

In all three cases the gastric remnant was small, and we have been assured by the radiologist that there was no evidence of hold up at the stoma. We believe that in these patients symptoms are attributable to the fact that the gastric remnant has not yet distended sufficiently, and that they should improve in time.

Of the twenty patients with mild symptoms after six months, most of whom only had symptoms after a large meal we believe to be due to the

fact that distension of the gastric remnant and jejunum have reached their maximum, but which is still insufficient to cope with the quantity of food they ingest.

FOODS INDUCING POST PRANDIAL DISTENSION -

Patients with this complaint stated that except in severe cases they could manage two small courses of each meal, but not more. Soup taken as the first course frequently resulted in marked distension by the end of the second course.

Patients therefore avoided soups. The chief offender in the third course was milk puddings, why this should have been is not clear. Of the twenty patients some twelve volunteered the information that they were most intolerant of this form of sweet. Fourteen of the patients adhered to the post-operative ulcer diet because they found it caused less distension than other types of food.

TREATMENT was not easy. In general we advocated the taking of six small dry meals a day instead of the usual three large ones. The taking of the six small meals prevented distension - fluid was taken between meals. As many of these patients were working they found it difficult to take the six meals - 60 per cent stated they were benefitted by this regime.

POST GASTRECTOMY DIARRHOEA

Various authors have from time to time reported chronic diarrhoea as a complication of gastric resection, Bloch (1936) and Browne and

McHardy (1943). In the present series there was not a single instance of this complaint. Indeed the regularity of these patients' bowel habits was a noteworthy feature. Five patients stated that normally their bowels moved twice daily, fifty once daily and the remaining twenty every second or third day. This last group included several patients with marked constipation.

Six patients gave a history of transient diarrhoea for between five and eight days shortly after the operation. Of these patients four were achlorhydric and two had free acid.

It is surprising that patients rendered achlorhydric by partial gastrectomy should not be more prone to attacks of diarrhoea. The food passes directly through an achlorhydric stomach into the jejunum. Such a finding seems to detract from the importance of free hydrochloric acid in the gastric juice as a protecting factor against infection passing into the bowel (Hurst).

CHAPTER XVHYPOGLYCAEMIA FOLLOWING PARTIAL GASTRECTOMY

During a routine follow-up of forty-five consecutive patients on whom a partial gastrectomy had been performed for peptic ulcer we noted symptoms of dizziness, palpitation, sweating, epigastric discomfort, and a feeling of weakness - progressing in several instances to complete loss of consciousness - in seventeen. These symptoms, coming on in from one-half to one and a half hours after food, were rapidly relieved by taking sugar or other easily assimilated carbohydrate. In this series they were far the commonest complication of partial gastrectomy, being greatly in excess of stomal ulcer and anaemia, which receive such a prominent place in the literature on the subject. Five of the patients were in consequence so severely disabled that they had become totally unfit for employment. Many of them, however, did not associate their symptoms with their operation, as their sensations seemed to be quite unconnected with the previous dyspepsia. In a follow-up of patients who have had a partial gastrectomy this syndrome may therefore be overlooked unless leading questions are asked.

HISTORICAL REVIEW -

The first articles on this complication of partial gastrectomy appeared in the German literature of the early 1930's. In 1933, Lapp and Dibold published their results of nine cases

of partial gastrectomy and one of gastro-enterostomy selected at random. This series includes six men and four women, the operation being carried out for gastric and duodenal ulcer and gastric carcinoma. In all cases the glucose tolerance curve showed a rapid initial rise of the blood sugar followed by a rapid fall to abnormally low levels - in one case to 42 mgm. per cent.

Beckerman in the same year, (1933) noted that patients who had undergone partial gastrectomy some many years previously, complained of sudden attacks of weakness, trembling, sweating and general unrest coming on after meals rich in carbohydrates and relieved by further carbohydrates. Since 1932 he had followed up thirty cases, ten of whom, partly by questioning and partly voluntarily, gave a history suggestive of post-prandial hypoglycaemia. In five of the ten cases he was able to demonstrate that the blood sugar fell to very low levels, 43, 16, 39, 33 and 18 mgm. per cent, and in one cases there were symptoms of profound hypoglycaemia when the blood sugar had fallen to 35 mgm. per cent.

Koranyi (1936) reported having carried out glucose tolerance tests in seventy-two patients. In only twenty-one cases was he able to demonstrate a fall during the hypoglycaemic phase of the blood sugar curve to below 70 mgm. per cent, and in only three cases i.e. 4 per cent were there

/ symptoms

symptoms of hypoglycaemia during the glucose tolerance test.

Wörhle (1936) found hypoglycaemic blood sugar curves in eight out of nine post-operative partial gastrectomies.

Eusterman and Balfour in their textbook also make note of this complication.

Swartz, Reingold and Necheles (1942) could find no correlation between the glucose tolerance curve and the symptoms of weakness, sweating, dizziness and palpitation coming on after meals in patients who had had a partial gastrectomy.

Evenson (1942) in the most comprehensive review of the subject to date reported hypoglycaemic glucose tolerance curves in thirty-eight of ninety-five cases - in these cases the blood sugar fell to 65 mgm. per cent or less.

Gavin Miller (1946) also reported hypoglycaemia as a complication of partial gastrectomy and noted one case in which the blood sugar fell to 35 mgm. per cent.

We would here stress that in taking the history of these cases with reference to hypoglycaemia, one must on occasions ask leading questions in order to obtain a history of this symptom complex; the reason being that when one asks patients who have been subjected to partial gastrectomy how they feel, the great majority will reply "very well" because in their minds, as in the minds of many of their medical advisers,

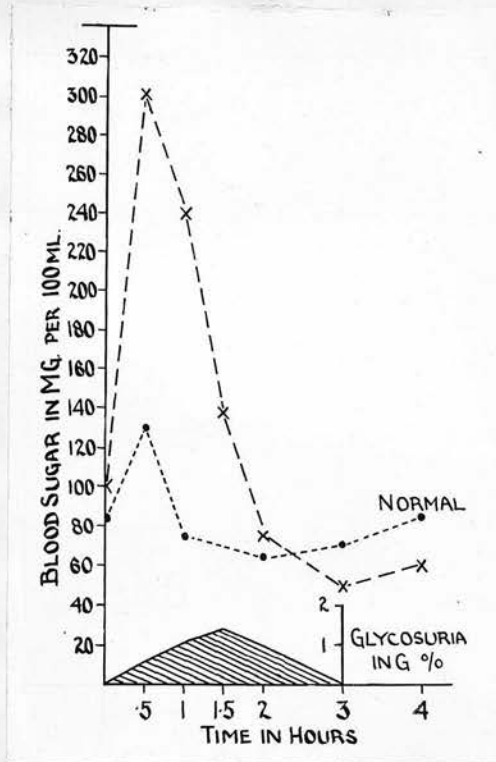
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the success of the operation depends on whether or not their epigastric pain has been relieved. The symptoms of sweating about the face, tachycardia, and fainting being far removed anatomically from the epigastrium, such patients think these symptoms could have no possible relationship to the operation and do not, unless the symptoms are severe, volunteer such information in their history.

During our routine follow-up of cases of partial gastrectomy we have found that seventeen out of forty-five consecutive cases, i.e. 37.7 per cent, the patients have had symptoms of hypoglycaemia of varying severity, in five cases severe enough to render the patient unable for work of any type, in other cases merely causing mild lassitude, weakness and sweating after meals. Many patients who have been subjected to this operation and who pre-operatively have been heavy manual workers will, after the operation, state that they no longer feel capable of carrying on with their previous occupation and have procured employment of a much lighter character, for example, a patient who was a miner at the pit face pre-operatively now is completely exhausted after an eight hour shift of watching a pump. A patient who pre-operatively was employed in a brewery storing heavy casks of beer, since operation has found himself unfit for this arduous occupation and now has become a night watchman at the same brewery. We feel that

/although

GRAPH 1



Case 1. Glucose tolerance curve. Note the sharp rise in blood sugar to 301 mg. and the fall to 53 mg., also a glycosuria of 1.6 g. during the peak of the blood sugar curve.

although many of these patients may not give a clear cut history of hypoglycaemic attacks, nevertheless these symptoms of weakness and inability to carry out their previous occupations in the absence of other complications, such as stomal ulcer, anaemia and epigastric pain, may be exhibiting mild manifestations of hypoglycaemia.

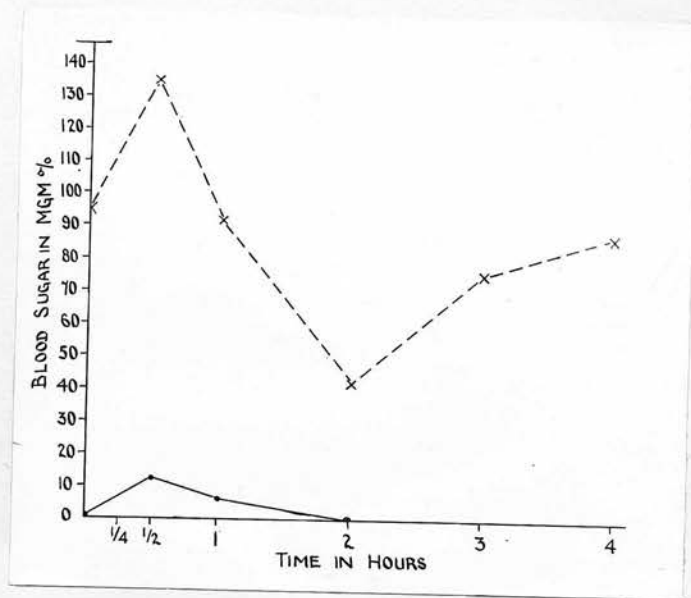
TECHNIQUE OF GLUCOSE TOLERANCE CURVES -

Glucose tolerance tests were performed on all forty-five patients. On the morning of the test a sample of fasting venous blood was withdrawn. The patient was then given 50 g. of glucose in 180 ml. of water orally, and samples of venous blood were withdrawn at 30, 60, 120, 180 and 240 minutes. In the latter half of the series an additional specimen was taken at 15 minutes. The sugar content of the blood specimens was estimated by the Hagedorn-Jensen method. Concomitant with the taking of the specimens the bladder was emptied and the urine was examined for sugar.

Graph 1 is the one which first brought the possibility of post-operative hypoglycaemia to our attention. Before his operation for a gastric ulcer two years ago this patient was employed as a gardener and, although for the four or five years immediately before the operation had lost between one and two months work a year due to epigastric pain and vomiting, had been able to carry on fairly satisfactorily at his work. When we asked the doctor's permission to have this

/ patient

G R A P H 2



Note - 1.2 gm. per cent glycosuria with blood sugar reading of 135 mgm. per cent. Presumably peak of blood sugar curve had been missed.

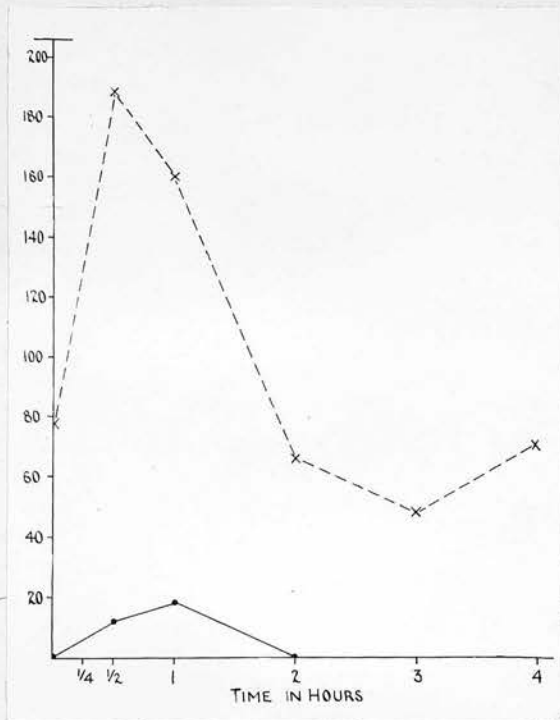
patient admitted for our routine follow-up, the doctor stated he would be very grateful to have our opinion because, since operation, the patient had suffered from attacks which the doctor took to be epileptic in nature and which had not responded to the usual therapy with phenobarbitone and phenytoin. On admission, the patient stated that about one hour after meals he felt extremely weak, dizzy and perspired freely - on one or two occasions having progressed to actual loss of consciousness. The symptoms were relieved to some extent by lying down for an hour or so after meals. His glucose tolerance curve shows the initial steep rise in the blood sugar to 301 mgm. per cent followed by the rapid fall to 53 mgm. per cent. It will be noted that during the period of high blood sugar level the patient had glycosuria to the extent of 1.6 gms. per cent.

Graph 2 - male age 35 who since operation had suffered from typical attacks of hypoglycaemia half an hour after meals. Although his blood sugar rose only to 135 mgm. per cent in the half hour specimen, yet he showed a glycosuria at that time of 1.2 gm. per cent. It was apparent that, by taking the first specimen at 30 minutes, we had missed the peak of the curve which must have gone well above 160 mgm. per cent, assuming that he did not have a low renal threshold.

Graph 3 - male age 24. This patient had fairly severe symptoms of hypoglycaemia following a partial gastrectomy for a duodenal ulcer a few

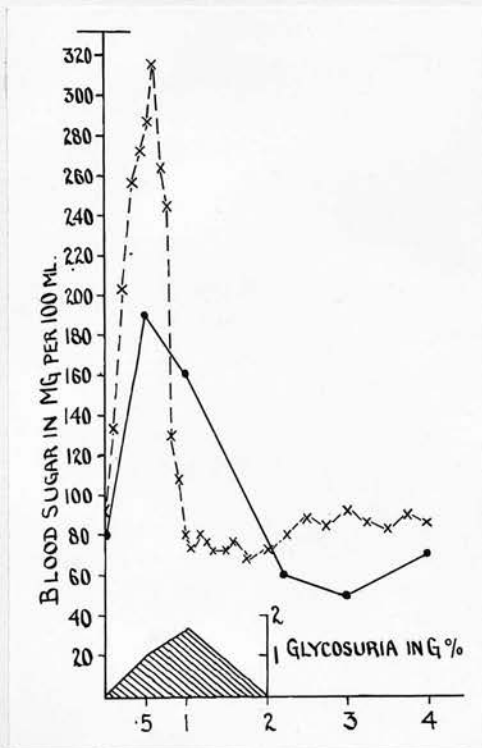
/ months

G R A P H 3



Glycosuria of 1.8 gm. per cent with blood sugar reading of 190 mgm. per cent. Presumably peak had been missed.

G R A P H 4



Specimens taken at 5 minute intervals demonstrate a true peak to be 312 mgm. per cent - missed in 30 minute specimen, Graph 3.

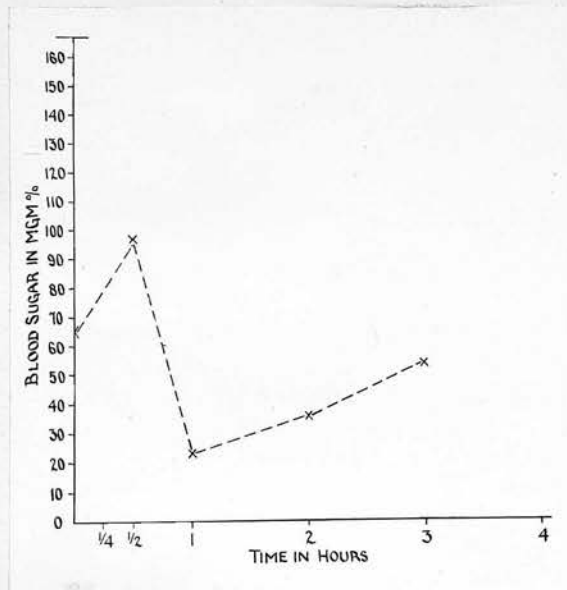
months previously. His hypoglycaemic symptoms were much more pronounced following high carbohydrate meals. On one occasion, after a large carbohydrate tea he boarded a 'bus going to Edinburgh. However, instead of disembarking at one of the suburbs, he found himself at the terminus with the conductor wakening him; he was bathed in perspiration, very dizzy and had severe tachycardia. In his glucose tolerance curve it will be noted that the highest reading was only 187 mgm. per cent in spite of the fact that he had 1.8 gm. per cent of glucose in his urine. Again we presumed that, by taking the specimens at 30 and 60 minutes we had missed the peak.

On repeating the test taking 5 minute specimens the peak was found to be 312 mgm. per cent - Graph 4. As it is impracticable and also hardly fair to the patients to do 5 minute specimens on all, a compromise was made in the latter half of the series when an additional specimen at 15 minutes was withdrawn.

Not in all cases does one get the brisk rise in the blood sugar to high levels - Graph 5, is that of a woman of 41 who, six months previously, had had a partial gastrectomy for a duodenal ulcer. Since the operation this patient had suffered from the most profound attacks of hypoglycaemia $\frac{1}{2}$ - 1 hour after meals. During the glucose tolerance test the blood sugar rose to only 96 mgm. per cent but fell to the very low

/ level

GRAPH 5



- Note - 1. Minimal rise in blood sugar following 50 gms. of oral glucose due to brisk response of islet tissue.
2. Low minimal level 23 mgm. per cent. accompanied by profound hypoglycaemic symptoms.

T A B L E XLII

INCIDENCE OF HYPOGLYCAEMIC SYMPTOMS					
	HYPOGLYCAEMIC SYMPTOMS		ASYMPTOMATIC		TOTAL
	MALE	FEMALE	MALE	FEMALE	
NO. OF CASES.	12	5	24	4	45
SITE OF LESION					
DUODENAL ULCER	7	2	16	0	25
GASTRIC ULCER	5	3	8	4	20
OPERATION.					
POLYA	12		18		30
HOFFMEISTER	5		10		15
FREE ACID IN POST-OPERATIVE TEST MEAL	7		10		17
AGE (YEARS)	30-65 (AVERAGE 45.58)		32-65 (AVERAGE 42.61)		
POST-OPERATIVE PERIOD (MONTHS)	4-84 (AVERAGE 33.29)		9-121 (AVERAGE 48.5)		

level of 23 mgm. per cent at which stage the patient was sweating freely, had a pulse rate of 110 per minute and was on the verge of losing consciousness.

ANALYSIS OF MATERIAL - Table XLII -

Glucose tolerance curves were carried out on forty-five consecutive cases admitted for follow-up examination - thirty-six of the patients being males and nine being females.

Of the forty-five cases, seventeen had symptoms of hypoglycaemia - these cases were divided into severe and moderate.

Severe Cases - These were patients who, by virtue of the severity of their hypoglycaemia, were rendered incapable of earning a livelihood.

Moderate Cases - include all cases not labelled severe and into this group fall patients with symptoms varying from mild tachycardia and sweating after meals to complete loss of consciousness.

ANALYSIS -

Duodenal Ulcer - Nine or 36 per cent of the twenty-five cases in this group were symptomatic, two severe and seven moderate. The two women patients were both symptomatic, one severe and one moderate, giving 100 per cent symptomatic - but two cases only are of no real significance. 30.43 per cent of the males fell into the symptomatic group.

Gastric Ulcer - The figures for this group are very similar to those of the duodenal group, 40

per cent symptomatic. Sex incidence was virtually the same for males and females, 40 per cent and 42.85 per cent respectively. Of the eight symptomatic cases three were severe and five moderate.

RELATIONSHIP OF HYPOGLYCAEMIA TO -

(a) Age of the Patient. Almost identical findings were present in the two groups, the average in the symptomatic cases being 45.58 years and in the asymptomatic 46.21 years.

(b) Post-operative Period. Showed a difference of 15.1 months being on the average 48.5 months in asymptomatic and 33.29 in the symptomatic. A possible explanation of this difference may be that the symptomatic group includes patients who, in the course of time, will become accustomed to the rapid changes in blood sugar, no longer exhibit symptoms and thus will fall into the second group later.

(c) Presence of Free Acid in the Post-operative Test Meal. These figures also are very similar, free acid being present in seven (41.18 per cent) of the symptomatic and ten (35.71 per cent) of the asymptomatic.

The post-operative period, the age of the patient and the presence or absence of free acid in the post-operative test meal would, therefore seem to bear no relationship to the development of hypoglycaemic symptoms.

PATHOLOGICAL PHYSIOLOGY -

The high speed of gastric evacuation. (Chapter

XIII) is, we believe, the basis of the hypoglycaemia. When the patient takes a meal it leaves the stomach through the newly-created non-valvular stoma abnormally quickly. Schindler, 1943, feels that in some cases the stoma does take on the function of the pylorus to some extent by developing a valve-like action. The precipitous gastric evacuation is particularly marked after the ingestion of food rich in carbohydrate, the staple food-stuff of the majority of these patients. This carbohydrate is then rapidly absorbed from the upper part of the small intestine, causing an initial brisk rise in blood sugar - an observation made previously by Beckerman, Lapp and Dibold, Koranyi, Kalk and Meyer (1932), Glaessner, Miller, Evenson, Swartz, Reingold and Necheles, and Adlersberg, and Hammerschlag (1947).

This very rapid initial rise in blood sugar stimulates the secretion of endogenous insulin, but here the curve differs from the normal. In a normal person the stomach takes $3\frac{1}{2}$ to $4\frac{1}{2}$ hours to empty. During this period food, in small quantities, is continually entering the jejunum and being absorbed, thus preventing the sharp rise in blood sugar.

In the partially gastrectomised patient all, or practically all, the food is absorbed from the jejunum in the first half hour at the end of which time the secretion of endogenous insulin is at its height - this results in a rapid fall in the

/ blood

T A B L E X L I I I

AVERAGE READINGS OF GLUCOSE TOLERANCE CURVES

	HYPOGLYCAEMIC SYMPTOMS	ASYMPTOMATIC
NO. OF CASES	17	28
MAXIMUM FALL	118.53 mg.	79.57 mg.
MINIMUM LEVEL	54.24 mg.	62.5 mg.
MINIMUM FALL PER MINUTE	2.69 mg.	1.92 mg.
MAXIMUM LEVEL	171.53 mg.	138.82 mg.
GLYCOSURIA	52.82 %	17.86 %
POSTPRANDIAL DIURESIS	47.05 %	29.26 %

blood sugar to subnormal levels and it is concomitant with this fall that the patient develops the symptoms of hypoglycaemia.

FACTORS IN CAUSATION OF HYPOGLYCAEMIC SYMPTOMS -

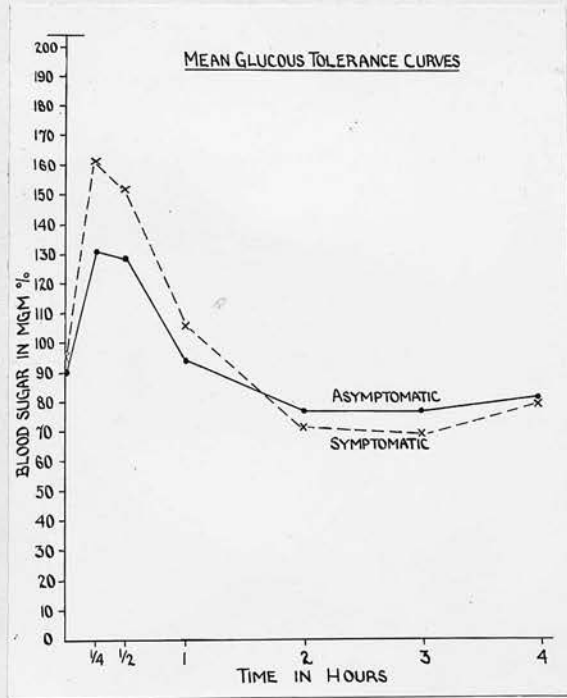
There are three factors to be considered which determine whether or not the patient will develop the symptoms of hypoglycaemia (Table XLIII).

(a) The Maximum Fall. By subtracting the lowest reading from the highest during the glucose tolerance test, one is given the maximum fall. In the symptomatic cases this fall was 118.53 mgm. per cent, while in the asymptomatic cases it was considerably less being 79.57 mgm. per cent.

(b) The Minimum Level. It is a well recognised fact that there is a wide individual variation for the blood sugar level below which a patient will develop the symptoms of hypoglycaemia, but readings below 50 mgm. per cent would, in most people, be associated with definite symptoms. The minimum level, in the symptomatic cases in this series was 54.24 mgm. per cent, while in the asymptomatic cases it was almost 10 mgm. per cent. higher being 62.5 mgm. per cent.

(c) Maximum Fall in mgm. per minute. This third factor is a very important one. The rate of fall in the blood sugar is analagous to the loss of blood from the body. If one loses blood slowly, e.g. chronic bleeding piles, the haemoglobin may fall to 40 - 50 per cent without producing startling symptoms, whereas if, by very sudden

GRAPH 6



Note - Symptomatic cases have higher maximum level, and fall more rapidly to a lower minimum level.

loss of blood from the severing of a main artery the haemoglobin fell to these levels the patient would exhibit profound shock or might even be moribund. So with the fall in blood sugar and the production of hypoglycaemic symptoms.

By taking the steepest part of the descent of the blood sugar curve and dividing it by the time interval we have found the maximum rate of fall of blood sugar in mgm. per minute.

Again this factor was more pronounced in the symptomatic than in the asymptomatic cases being 2.69 mgm. per minute and 1.92 mgm. per minute. These three factors are, then, all of more significance in the symptomatic than in the asymptomatic cases in this series. These figures have been checked and found to be of statistical significance.

Graph 6 contrasts the average glucose tolerance curves in the seventeen symptomatic, and in the twenty-eight asymptomatic cases, and demonstrates that these three factors are all more marked in the former cases.

GLYCOSURIA

Glycosuria occurred in 33.33 per cent of cases in this series, being present in 58.82 per cent of the symptomatic and 17.86 per cent of the asymptomatic. The basis of this glycosuria is the rapid initial rise in blood sugar. Should the level exceed the usual renal threshold of 160 mgm. per cent sugar will appear in the urine. The reason that it occurs more frequently in the

/ symptomatic

symptomatic cases is associated with the fact that, on the average the maximum level of the blood sugar in the symptomatic cases was 42 mgm. per cent higher than in the asymptomatic, the readings being 171.53 and 138.82 mgm. per cent respectively.

In one case glycosuria was of some interest because the patient had not been gaining weight since the operation. The patient's doctor tested the urine, found it to contain sugar, suspected Diabetes Mellitus and referred him to the Royal Infirmary, Edinburgh. Evenson reports two similar incidents.

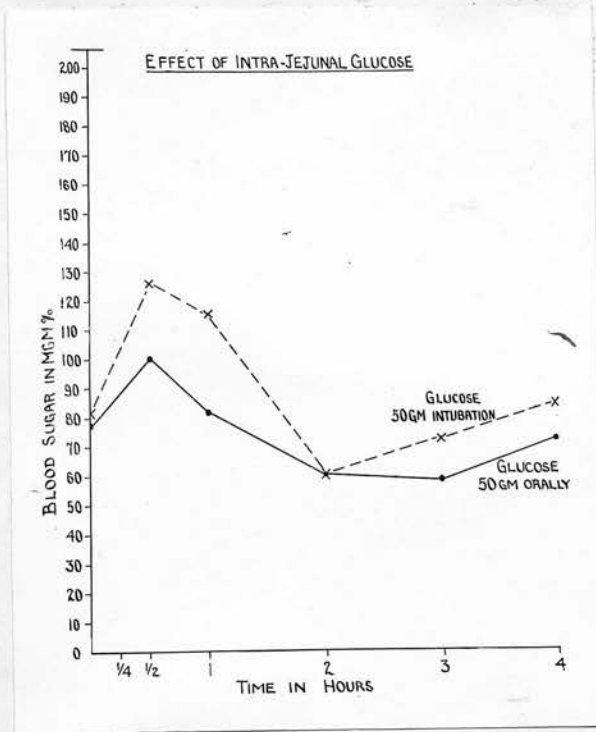
G.G. Taylor et al (1928) in their follow-up found glycosuria in seven out of fifty-two cases in which they examined the urine. However they make no comment on the significance of this finding nor did they carry out glucose tolerance curves. Adlersberg and Hammerschlag noted it in eight of thirteen cases suffering from the "post-gastrectomy" syndrome.

POST PRANDIAL DIURESIS

This was noted in nineteen of the cases, i.e. 42.2 per cent, being present in 47.05 per cent of the symptomatic and 39.26 per cent of the asymptomatic. This finding was also noted by G.G. Taylor et al and later by Snell (1937). The basis is again the rapid emptying time of the gastric remnant accompanied by speedy absorption of the fluids taken with the meal.

DISCUSSION ON MECHANISM OF HYPOGLYCAEMIA

GRAPH 7



Intra-jejunal Glucose

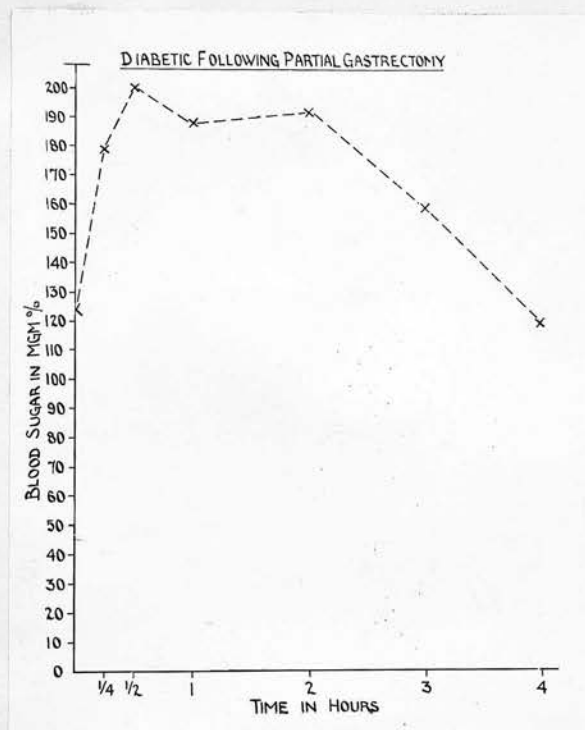
- (a) Produced initial higher level of blood sugar.
- (b) Failed to produce reactionary hypoglycaemic level due to glucose leaking back into the stomach.

We have put forward our theory on the production of this post prandial hypoglycaemia - namely that the unduly rapid emptying of the gastric remnant into the jejunum caused a brisk rise in the blood sugar which resulted in a relative overproduction of endogenous insulin resulting in a sharp fall in blood sugar to abnormally low levels which brought on the symptoms of hypoglycaemia. This is the theory held by Beckerman who, in addition, has shown that the powers of absorption of the upper jejunum for carbohydrate are increased following partial gastrectomy. In ten patients who, subsequent to partial gastrectomy complained of hypoglycaemic symptoms, he carried out glucose tolerance tests and in five cases he was able to demonstrate a marked hypoglycaemic picture with the blood sugar falling to 43, 16, 39, 33 and 18 mgm. per cent.

We have attempted to simulate the conditions present in the partially gastrectomised patient by introducing a tube into the jejunum and administering through it 50 gm. of glucose in 180 c.c. of water over a period of 15 minutes.

As will be seen in Graph 7 by first carrying out an oral glucose tolerance curve and then a curve following glucose by intra-jejunal intubation we were able to produce a slightly higher initial rise in the blood sugar. The reason we have failed in two cases to produce the typical curve of the partially gastrectomised is, we believe,

GRAPH 8



Effect of diabetes on blood sugar curve of patient with gastric resection.

- Note - 1. Prolonged high level of blood sugar.
2. Slow fall to fasting level, due to failure of insulin secretion.

not that our hypothesis is wrong but our technique was at fault. After administering the glucose through the tube, the tip of which had previously been shown by X-Ray to be in the jejunum, we withdrew it as far as the stomach and on aspirating the stomach found it to contain 80 c.c. of glucose which we then replaced. This presence of glucose is due to the fact that it leaks back through the pylorus into the stomach, which it then leaves over the normal 2 - 3 hours and so produces flattening of the curve. Wörhle in only one of three cases was able to produce this type of curve by intra jejunal glucose administration. Kalk and Meyer (1932), however, seem to have been singularly successful in this method of producing blood sugar curves similar to those in the partially gastrectomised patient.

→ We have support for the belief that the fall in blood sugar is due to the over secretion of endogenous insulin (from Graph 8), which is that of a mild diabetic patient not receiving insulin who had been subjected to a partial gastrectomy. It shows the sharp initial rise in the blood sugar but, owing to the inability of the pancreas to secrete insulin, the fall in blood sugar is less marked and occurs more slowly than in the non diabetic case.

Koranyi, who carried out a follow up on seventy-two cases of partial gastrectomy, found that in 3 per cent of these patients the glucose / tolerance

tolerance curve fell below 70 mgm. and in only 4 per cent of cases did the patients have symptoms of hypoglycaemia. He also noted, as have we, that there was a wide individual variation and that in a few cases the blood sugar fell below 50 mgm. per cent without producing symptoms. Koranyi's 4 per cent of cases with hypoglycaemic symptoms were all in patients in whom the operation had been carried out under local anaesthesia. He concluded from these observations and by animal experimentation in which he subjected dogs to partial gastrectomy, and the injection of 10 per cent alcohol in the coeliac ganglion, that damage to the splanchnic nerves was the basis of this hypoglycaemia. De Takatas and Cuthbert also found that coeliac ganglionectomy in dogs resulted in typical hypoglycaemic blood sugar curves. However, in this series all patients were operated on under general anaesthesia and therefore damage to the splanchnic nerves or coeliac ganglion from any ulterior effect of local anaesthesia can be excluded; also anatomically it would seem to be unreasonable that by a routine Polya operation the surgeon would cause any serious damage to these structures.

The question might well be asked whether or not the hypoglycaemic curves could be attributed to increased insulin sensitivity in these patients. We have carried out insulin tolerance tests on a

/ few

few and have found them to be normal. Although these patients have a normal sensitivity to insulin it may be that many of them have very active pancreatic islet tissue which is easily stimulated by carbohydrates, e.g. Graph 5 where the blood sugar after 50 mgm. of glucose rose only to 96 mgm. per cent but fell to 23 mgm. per cent; we assume this to be one such case. That the islet tissue in these patients, though capable of secreting large amounts of insulin when stimulated but not otherwise, is shown by the fact that their fasting blood sugars are normal - average 90.8 mgm. Adlersberg and Hammerschlag, Beckerman and Evenson have also drawn attention to the normal fasting blood sugar, which immediately differentiates this condition from that of a pancreatic adenoma, in which the excessive production of insulin is continuous producing an abnormally low fasting sugar.

Of the seventeen symptomatic cases we were able to produce hypoglycaemic manifestations in six instances only by the routine administration of 50 gm. glucose orally. The reason, we believe, as does Evenson, is that normally these patients would be active instead of lying in bed half to one hour after a meal and that this bodily activity, by utilising carbohydrate, causes the blood sugar to fall to lower levels than we were able to obtain by having the patients in the ward as the investigations necessitated. Evenson

/ proved

proved this point by taking four of his patients who did not develop symptoms with the ordinary glucose tolerance test and repeating the test, making the patients take severe exercise as soon as the blood sugar curve reached its height. In all four cases (a) the blood sugar fell to lower levels than occurred with the patient at rest, and (b) the patients developed symptoms of hypoglycaemia.

That the cause of the hypoglycaemia is the result of the operation which has resulted in a short circuiting has been convincingly demonstrated by Evenson. A further observation by Evenson confirms short-circuiting to be the basis of the hypoglycaemia. He observed a high incidence of hypoglycaemia after gastro-enterostomy. In one such case the reconstitution of the normal alimentary tract immediately removed this abnormality from the glucose tolerance curve.

This would seem to show conclusively that the basis of the pathological hypoglycaemia is to be found solely in the gastric emptying. Were it due to other factors (such as changes in pancreatic functions) the blood sugar would not have returned to normal so soon after the operation.

As the level of the blood sugar is dependant upon the rate of absorption from the small bowel and also on the rate of removal of sugar by the tissues, it was necessary to determine whether the hyperglycaemic phase was due to failure of the tissues to remove glucose from the blood and

the hypglycaemic phase due to excessive removal. That such was not the case was shown by the fact that the capillary-venous difference of blood sugar was normal i.e. 25 mgm. per cent.

Certain physiological observations might seem to deny the possibility that rapid emptying of the stomach may lead to increased absorption, for it is known that glucose and certain hexoses are absorbed selectively in the intestine. The rate of absorption being the same, independent of the amount of sugar actually present.

In order to correlate this fact with the results of the present investigations it is assumed that only a small part of the intestinal surface participates in the absorption under normal conditions. In the case of rapid emptying, large quantities of glucose pass at once into the intestine and the solution is distributed over a wider surface which is thereby brought into function.

The rapid emptying also explains the frequency with which these patients' blood sugars fall to abnormally low levels after meals. It is known that the absorption of glucose takes place very rapidly. That the gastric emptying time is precipitated is also established. With these two factors in action absorption is completed more quickly than normal. When the gastro-intestinal tract becomes empty sooner than is normal no sugar is present which can compensate for the fall in blood sugar.

PHYSIOLOGICAL BASIS OF TREATMENT
OF POST PRANDIAL HYPOGLYCAEMIA

Since the basis of the post-prandial hypoglycaemia is presumably due to abnormally rapid gastric evacuation followed by a rapid rise in blood sugar with a subsequent fall to hypoglycaemic levels the rational aim in treatment would seem to revolve around -

- (a) Prolongation of the period of gastric evacuation;
- (b) Reduction in the rate of absorption of glucose from the jejunum; and
- (c) Prevention of the reactionary fall in blood sugar to hypoglycaemic levels - or a combination of these.

(a) To prolong the period of gastric evacuation -

From time to time many surgical modifications of the basic Billroth II operation have been attempted with this as their object - the most popular being the Hoffmeister modification, Diagram IV in which the anastomatic margin is stitched far down so as to leave only a small opening into the jejunum.

It would seem to the authors that until the surgeon can produce a valvular stoma instead of a mere hiatus between the stomach and jejunum this state of rapid gastric evacuation is likely to continue.

In the forty-five cases which we investigated in regard to post prandial hypoglycaemia, fifteen patients had had Hoffmeister operations, of these

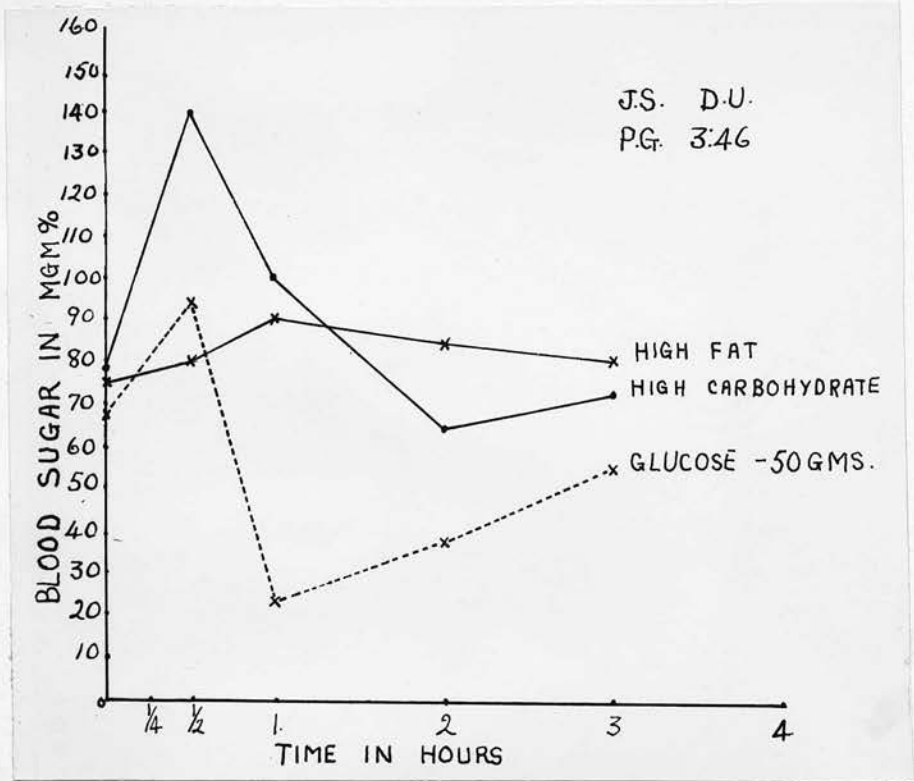
five had symptoms of hypoglycaemia, i.e. $33\frac{1}{3}$ per cent, which would seem to indicate that this operation has little effect in ensuring freedom from this complication.

With the recent introduction into this country of supra-diaphragmatic vagal section as a therapeutic measure in peptic ulceration we have had the opportunity of carrying out glucose tolerance curves in two cases, and have found that post-operatively the curves are normal. (Johnston at the British Post-Graduate Medical School has made a similar observation over a very much larger series).

Should this operation continue to maintain the highly satisfactory results claimed for it by Dragstedt (1947), Moore (1947), Wangansteen (1946), Johnston (1947) and others, in its ability to prevent recurrent ulceration and also eliminate post prandial hypoglycaemia, it will indeed be a great step forward in the treatment of peptic ulcer.

Medically the agents at our disposal for delaying gastric evacuation are not so potent. Quigley (1943) has shown that in gastric evacuation in dogs the rate of gastric emptying is controlled chiefly by the alimentary pressure gradients and not by the pylorus. The work of Abbott et al (1943) suggests that the same may be true in man. Johnston (1935), Shay and Gershon-Cohen (1936) have shown that hydrochloric acid, fat and hypertonic solutions introduced into the jejunum distal to the anastomosis caused delay in the gastric emptying

GRAPH 9



Note - (a) Glucose 50 gms.

1. Slight rise in blood sugar (96 mgm. per cent - Graph 5)

2. Rapid fall to very low level (23 mgm. per cent.)

(b) High carbohydrate diet produced somewhat similar curve to (a)

(c) Effect of high fat diet in stabilising level of blood sugar curve.

and that this delay was due to relaxation of the gastric musculature. The subsequent fall in intra-gastric pressure may be accompanied by a rise in intra-enteric pressure due to either (a) the sudden influx of food causing increased tonus of the small intestine or (b) to a rapid increase in the volume of the intestinal contents, because of a rapid outpouring of enteric juices which take over the diluting functions normally carried out in the stomach. The net result is a decrease in the pressure gradients with delayed gastric evacuation. This depressant action of fat on gastric peristalsis has been shown to be due to the liberation of the hormone entrogastrone, Ivy (1937). Upon the basis of this work we have used diets containing large amounts of fat

Graph 9.

This patient (Graph 5) suffered from severe attacks of hypoglycaemia and during the glucose tolerance test her blood sugar fell to the lowest reading we have in this series, i.e. 23 mgm. per cent. On a high carbohydrate diet she was very prone to attacks of hypoglycaemia. When, however, using the same number of calories, but giving half of them as fat and half as carbohydrate, the blood sugar curve became much more normal, there being an absence of the steep initial rise and no reactive fall. However, not all patients, especially after partial gastrectomy are able to take such large quantities of fat - 2 ozs. per / meal

meal - without feeling nauseated especially when the fat has to be given as margarine or olive oil. In peace-time with available cream and fats in a more palatable form, patients would, no doubt, have less difficulty in adhering to such a diet. The giving of hydrochloric acid by mouth has had little beneficial effect in our cases. In view of the fact that, of the patients suffering from hypoglycaemia, some 41.18 per cent have free hydrochloric acid even as much as 50 units, achlorhydria as the cause of the hypoglycaemia would seem to be very doubtful. In addition we have found patients can sip only about 2 drachms of N/10 hydrochloric acid with each meal, an infinitesimal amount compared with that normally secreted by the gastric mucosa - such therapy has been singularly unsuccessful in the achlorhydric hypoglycaemic cases.

(b) Reduction in the rate of Absorption of Glucose from the small Intestine. -

The only methods by which one could achieve this object would seem to be as follows:

(a) By reduction in the intra-intestinal pressure. Bamberger showed that as the intra-intestinal pressure is increased so is the absorption of glucose. In the partially gastrectomised patient the rapid emptying of the stomach may cause an increased intra-enteric pressure and more rapid initial rise in blood sugar. The reduction of the intra-enteric pressure could be

/ achieved

achieved by (a) the prolongation of the gastric evacuation; (b) by coating the upper intestine with some slowly absorbed food which would hinder the absorption of glucose. The taking of fat in the early part of the meal or the giving of olive oil before a meal would have this function. Fat then performs the double function of delaying gastric emptying and also delaying absorption from the jejunum; and (c) prevention of the reactionary fall in blood sugar.

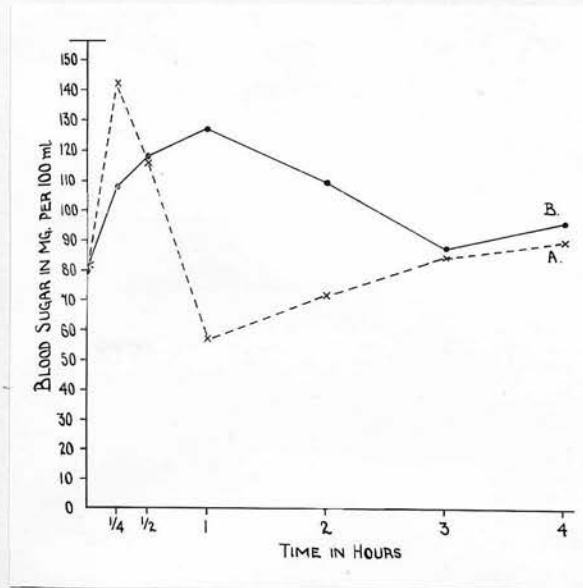
This would be prevented, at least to some extent by (a) and (b) i.e. by preventing the initial brisk rise in the blood sugar. Should we keep this rise within normal limits then the maximum fall in blood sugar would be less even though it fell to hypoglycaemic levels and, as we have shown, maximum fall in blood sugar is equally as important as the minimum level to which it falls in the production of hypoglycaemic symptoms.

Ephedrine by its sympatheticomimetic action raises the blood sugar. The administration of this drug in $\frac{1}{2}$ gr. doses before meals should have its maximum effect during the hypoglycaemic period. We have used this drug on four symptomatic patients.

All four patients stated that they felt improved, three complained of weakness during the first week of therapy and one also of slight diarrhoea. The fourth patient had no subjective

/ complaints

G R A P H 10



A = glucose tolerance curve without ephedrine.

B = curve after 1/2 gr. (32 mg.) of ephedrine had been taken half an hour before the glucose.

complaints. After the first week all four patients stated that they felt much improved, had more energy and no longer suffered from faintness, dizziness and perspiration after meals. Two patients, however, complained of mild insomnia which responded to phenobarbitone gr. 1 nocte.

In order to determine whether or not this improvement was purely subjective and due to the general stimulating effect of ephedrine, or to its action in preventing the fall in blood sugar we repeated the glucose tolerance test giving $\frac{1}{2}$ gr. of ephedrine half an hour before the second test. The results are shown in Graph 10.

THE DUMPING SYNDROME

- ITS RELATIONSHIP TO HYPOGLYCAEMIA

INCIDENCE -

The so-called "dumping syndrome" or "dumping stomach" was first described as a complication of partial gastrectomy by Hertz in 1913. The symptomatology of this syndrome includes a feeling of abdominal distress, sweating, weakness, tachycardia coming on shortly after a meal in patients upon whom a gastro-enterostomy or partial gastrectomy has been performed. Mix (1922) found this to be a rare complication as did Eusterman and Balfour (1935). Snell (1937) again referred to it as a rare complication following gastro-enterostomy with or without resection. "In a few cases" he stated "symptoms appear after meals, but once the stomach becomes accustomed to the new hook-up they tend to disappear".

Sara Jordon (1941) on the other hand, believes that in 25 per cent of the unsatisfactory results of partial gastrectomy the cause of failure is either the dumping syndrome or stomal ulceration. Mateer (1941) puts the figure at 14 per cent. Miller (1942) 17 out of 230 cases had post cibal symptoms.

Custer, Butt and Waugh (1946) in a very extensive review of the subject found that it occurred in 5.6 per cent of 500 partial gastrectomies carried out at the Mayo Clinic. They have divided the cases as follows:

Group A - 12 cases - typical symptoms but not sufficiently severe to interfere with normal activity.

Group B - 10 cases - patients sufficiently handicapped by post prandial distress to interfere with their work.

Group C - 6 cases - patients were not only unable to work but also suffered from more epigastric distress than they had done before the operation.

In 27 out of the 28 cases the operation performed was a Polya.

In another series of 112 cases by Waugh the "dumping syndrome" occurred in 14 i.e. 12.5 per cent.

Custer, et al reported that the symptoms could best be prevented by lying down after a meal. On questioning one of their patients as to how she felt since her operation she replied:

/ "Who

"Who wouldn't feel well spending two thirds of one's time lying down?".

PATHOLOGICAL PHYSIOLOGY

Many theories have been put forward as a basis for the dumping syndrome. The hypothesis that the cause of the symptoms is due to jejunal distension caused by the rapid gastric evacuation has long held the field. This distension is presumed to stimulate the vagus and the symptoms are attributed to vagotonia.

This theory would seem to have little to support it for the following reasons. Firstly, if one stimulates the vagus the pulse rate should become slower - we have found the converse to be the case - on an average these patients' pulse rates increased 10 - 15 beats per minute while the symptoms were present. Indeed tachycardia is one of the symptoms of the dumping syndrome.

Secondly, by giving a large dose of atropine i.e. 1/50 gr. which should "block" the vagus, we have failed to note any change in the symptomatology.

Thirdly, recently Moore (1947) reported a case of the dumping syndrome occurring in a patient in whom he had sectioned the vagi above the diaphragm.

Glaessner carried out blood sugar curves on nine cases of the "dumping syndrome" and drew the conclusion that the basis of the condition was hyperglycaemic shock. The points against

/ accepting

accepting this basis are we believe:

Firstly - By the intra-veneous injection of glucose raising the blood sugar to 400 mgm. per cent, in the course of 3 minutes has failed to produce symptoms.

Secondly - we are unaware of any symptoms caused by hyperglycaemia "per se"; and

Thirdly - in our cases at least, the symptoms occurred not during the rise but during the fall in blood sugar.

Swartz, Reingold and Necheles were unable to find any correlation between the glucose tolerance curve and the "dumping syndrome". However, their conclusions are open to severe criticism and have been adequately dealt with by Glaessner.

We believe that the basis of the "dumping syndrome" is the rapid emptying of the gastric remnant, as has been shown by Vitkin (1940), Custer, Butt and Waugh, G.G. Taylor et al and others, but that the symptoms are not caused by jejunal distension or hyperglycaemia but by hypoglycaemia.

In such cases if the feeling of upper abdominal discomfort is more marked than the tachycardia or dizziness the label of the dumping syndrome would be applied, whereas if the predominant symptoms were sweating and dizziness the designation would be hypoglycaemia. We believe that it is unnecessary to differentiate the two conditions which are identical.

As all our patients complaining of weakness,

/sweating,

sweating, tachycardia, faintness - even to the extent of loss of consciousness and upper abdominal weakness coming on half an hour after meals - showed the typical hypoglycaemic blood sugar curve, we feel that our theory is the correct one. And as Custer, Butt and Waugh noted, 20 per cent of their patients with the dumping syndrome remarked that the symptoms were more severe following meals rich in carbohydrates - which we have already pointed out is a feature of the patients complaining of hypoglycaemic symptoms. These authors, strangely enough, did not carry out blood sugar curves. Adlersberg and Hammerschlag in a recent article, May 1947, reported their results on 14 cases of the "dumping syndrome". These patients were all referred to a Nutritional Unit because of severe malnutrition following partial gastrectomy. These authors state that in all cases a hypoglycaemic type of blood sugar curve was obtained.

That hypoglycaemia can cause upper abdominal distress is not so simply explained, but we believe that it is due to increased peristalsis of the gastric remnant. It has been shown by many workers, particularly Hollander (1944), that a low or falling blood sugar will cause a great increase in gastric peristalsis, and it may well be that a fall in blood sugar sufficiently rapid to produce perspiration, dizziness, faintness and tachycardia might well not only increase the peristalsis of the gastric remnant but put it

into some degree of spasm which would account for the upper abdominal distress as a feature of the hypoglycaemic symptom complex.

As has been pointed out by many authors, Hertz, Moore, Custer, Butt and Waugh and others, the symptoms of the dumping syndrome are more marked in the first few months or years after the operation and subsequently tend to improve - such is also the case with the symptoms of hypoglycaemia. We believe that the reason that such cases of the dumping syndrome tend to improve with time is that, as with the hypoglycaemic, these patients gradually become acclimatised to the rapid fall in blood sugar which now fails to provoke the dramatic symptoms of which it was once capable.

The treatment essentially that of preventing the attacks of hypoglycaemia has been dealt with under that section. As has been noted, this is not always easy. Again Custer, Butt and Waugh recommend a regime precisely the same as we have recommended for hypoglycaemia - i.e. a diet rich in fat which will diminish the rate of jejunal absorption of carbohydrate - six small meals a day instead of three large ones, and the giving of ephedrine to prevent, by its sympathetomimetic action, the reactionary fall in blood sugar.

C H A P T E R X V I
A B S O R P T I O N

1. CARBOHYDRATE

The estimation of the stool carbohydrate content which is a difficult and unreliable process was not performed. However, the rapid rise in blood sugar following the ingestion of food (Chapter XV) would seem to indicate that the absorption of this foodstuff is adequate.

2. FAT

Of the various processes of absorption, that of fats appears to be the one most easily affected by gastro-intestinal disorders of all types. Earlier reports of steatorrhoea after gastrectomy are found chiefly in the European literature. Wolleager, Comfort, Weir and Osterberg (1947) reported that subsequent to partial gastrectomy the stool fat was slightly above normal on any fixed intake. In five cases we carried out fat balances, all of which were normal. In another ten the stool fats, split, unsplit, and total were estimated and again there was no abnormality.

3. NITROGEN

The subject of nitrogen metabolism is discussed fully under "Post-operative Weight". Elsom, Chornock and Dickey (1942) demonstrated conclusively that intestinal digestion of protein proceeds quite rapidly even in the relative absence of gastric juice. The oral glycine

/ tolerance

tolerance tests as carried out by Ariel et al indicate that amino acids are readily absorbed by patients with gastric resections. Of patients with total gastrectomy, Rekers Pack and Rhoads (1943), and Farris Ransom and Collier (1943) found increased stool nitrogen in only one out of four. Some people in their series found the stool nitrogen following resection to be essentially normal. In the three patients in whom we carried out nitrogen balances the stool nitrogen was in all cases less than 2.0 gms. per day, which we accept as being within the realm of normality. Various authors have, from time to time reported finding undigested meat fibres in the stools of patients subsequent to resection. We believe these observations are open to criticism. The interpretation of the microscopic appearance of the stool requires great skill, and the differentiation of undigested meat fibres from other elements in the stool is a task difficult for even those with profound experience in this field.

4. VITAMINS

Clinically, apart from three patients with cheilosis and glossitis associated with secondary anaemia, there was no evidence of vitamin deficiency. In all three cases the use of ferrous sulphate and nicotinamide relieved the anaemia and cheilosis but the glossitis was more resistant to therapy.

The serum ascorbic acid was estimated in all
/ cases

cases and ranged from 0.14 mgm. per cent to 0.4 mgm. per cent. Plimmer (1946) states that the lower limit of normality is 0.8 mgm. per cent. The figures for the present series are, however, within the range of normal according to the Clinical Laboratory of the Royal Infirmary, Edinburgh. In no instance was there clinical evidence of scurvy. Alt (1937) found lower values for serum ascorbic acid in patients with achlorhydria. Kindall and Chinn (1938) noted that the intestinal flora in achlorhydric patients destroyed 50 per cent of the ascorbic acid in twelve hours. We have failed to confirm these findings, the serum ascorbic acid being identical in patients with achlorhydria and those with free acid.

Simpson (1935) and Bean Spies and Bankenhorn (1935) have reported frank pellagra secondary to gastrectomy. Pack and McNeer (1943) have reported low prothrombin levels due to failure of vitamin K absorption. No evidence of these latter deficiencies was found in the present series.

C H A P T E R XVIIPOST OPERATIVE WEIGHT

As loss or gain in weight are generally regarded as a rough guide to the patient's health, particularly by insurance companies, we have paid special attention to this examination in the present series. The removal of a considerable portion of the stomach along with the associated short circuiting operation might theoretically lead to altered absorption from the gastrointestinal tract, and consequently a change in weight.

The patient's weight "per se" was not used as a criterion in the classification of results, because many people apparently in good health are considerably underweight, and a somewhat smaller percentage overweight. Consequently weight alone does not offer a sufficiently rigid basis on which to gauge results. The correlation of the patient's weight with the end results, however, has been of considerable interest in this series.

Five weight readings were used -

- (a) The pre-operative weight - this was obtained from the previous case history;
- (b) The present or post-operative weight;
- (c) The gain or loss over the pre-operative weight;
- (d) The theoretically correct weight for the patient's age and height; and
- (e) The difference between the actual weight

/ and

T A B L E XLV

(a)

WEIGHT ACCORDING TO SITE OF LESION						
DUODENAL ULCER	GAIN 45			LOSS 30		
	AVERAGE	MAXIMUM	MINIMUM	AVERAGE	MAXIMUM	MINIMUM
PRIMARY	12 lbs.	26 lbs.	1 lb.	7.83 lbs	12 lbs	4
SECONDARY	5 lbs.	8 lbs.	1 lb.	7.4 lbs	13 lbs	3
TOTAL	10 lbs.	26 lbs.	1 lb.	7.61 lbs	13 lbs	3
GASTRIC ULCER	16.1 lbs.	54 lbs	3 lbs.	13.7 lbs	30 lbs	2
STOMAL ULCER	7.7 lbs.	15 lbs	3 lbs.	10.4 lbs	14 lbs	5
AVERAGE GAIN 11.6 lbs				AVERAGE LOSS 10.4		

Distribution of patients on basis of post-operative gain or loss of weight according to site of primary lesion.

and the correct weight.

PRE-OPERATIVE WEIGHT -

All patients were below their theoretically correct weight, varying from minus 2 to minus 58 lbs. with a mean of 25.6 lbs.

The relationship between pre-operative weights and the primary indications for operation is given in Table XLIV. Patients with stenosis showed the deficit minus 30.5 lbs. average followed closely by those with pain and stomal ulcer, minus 27.6 lbs. and minus 27.4 lbs. respectively. Those least below their correct weight were the patients with recurrent perforation, minus 12 lbs. average.

PRESENT WEIGHT -

Taking the weight gained by all patients compared with that lost the average gain for the series was only 2 lbs. per patient. Analysing the cases more fully Table XLVa45 patients or 60 per cent gained weight - the average gain being 11.6 lbs; 30 patients or 40 per cent lost weight - the average loss being 10.4 lbs.

Church and Hinton (1941) over a three year follow up noted that 47.6 per cent of their patients lost weight, 39.2 per cent gained and 11.2 per cent were unchanged following partial gastrectomy for peptic ulcer. Browne and McHardy (1943) quoted a loss of weight in 20 per cent of their patients; Miller (1942) 10 per cent; Santy and Mallet-Guy (1939) 17 per cent and Jordon (1941) 27 out of 94 had difficulty in

/ maintaining

T A B L E XLV

(b)

AVERAGE BELOW CORRECT WEIGHT (ACCORDING TO INDICATION FOR OP.)

	PRE-OPERATIVE	POST-OPERATIVE	AVERAGE GAIN OR LOSS
PAIN 41	27.6 lbs	24.4 lbs	+3.2
STENOSIS 11	30.5 "	24.4 "	+6.1
RECURRENT PERFORATION 3	12. "	17. "	-5.
RECURRENT HAEMORRHAGE 6	23. "	16. "	+6.
?MALIGNANCY 6	15. "	25.4 .	-10.
STOMA 8	27.4 "	27.4 "	0.
AVERAGE	25.6 .	23.6 .	

- Note - 1. Patients with stenosis were most under-weight pre-operatively average 30.5 lbs. and gained most weight post-operatively average +6.1 lbs.
2. Patients operated on for possible malignancy showed the greatest weight loss post-operatively, average -10 lbs.

T A B L E XLVI

DISTRIBUTION OF PATIENTS

	GAIN		LOSS	
	No.	PERCENT.	No.	PERCENT.
DUODENAL ULCER:-				
PRIMARY	19	76%	6	24%
SECONDARY	8	53.33%	7	46.66%
TOTAL	27	67.5%	13	32.5%
GASTRIC ULCER:-	13	48.14%	14	51.86%
STOMAL ULCER:-	5	62.5%	3	37.5%
TOTAL	45		30	

Duodenal group - particularly "primary" cases contained the highest percentage of patients gaining weight post-operatively, 76 per cent compared with gastric 48.14 per cent, and stomal 62.5 per cent.

operated on for possible malignancy were only 2 lbs. more underweight than the average for the whole series, i.e. 25.4 lbs. to 23.6 lbs. and those operated on for recurrent perforation were 6.6 lbs. less underweight than the average for the series, i.e. 17 lbs. to 23.4 lbs. As this latter group includes only three patients the significance of these figures is of no real value.

(B) In Relation to Site of Original Lesion -

Table XLVa compares the post-operative gain or loss of weight according to the site of the original lesion. Of those patients who gained weight, the highest average gain was in cases of gastric ulcer 16.1 lbs. and the lowest in stomal ulcer 7.7 lbs. Of the patients who lost weight again the greatest loss was in cases of gastric ulcer 13.7 lbs. and least in duodenal ulcer 7.61 lbs.

Table XLVI shows the percentages of patients who lost or gained weight according to the site of the original lesion. It will be noted that 67.5 per cent of duodenal cases gained compared with 48.14 per cent of gastric ulcer cases. Of the duodenal ulcer patients the greatest percentage of gaining weight was in the "primary group" 76 per cent. The percentage for stomal ulcers of 62.5 per cent more closely approximates the duodenal than gastric group.

RESULTS IN RELATION TO POST-OPERATIVE WEIGHT -

Classifying the results according to the post operative loss or gain of weight it was noted

/ that

T A B L E XLVII

RESULTS IN RELATION TO POST-OPERATIVE WEIGHT

	NO GAIN - 30		GAIN-45	
	No.	PERCENT.	No.	PERCENT.
CURED 29	3	10.00%	26	57.77%
IMPROVED 20	7	23.33%	13	28.88%
I.S.Q. 7	5	16.66%	2	4.44%
FAILURES 19	15	50.00%	4	8.88%
TOTAL	30	100.00%	45	100.00%
SATISFACTORY	10	33.33%	39	86.65%
UNSATISFACTORY	20	66.66%	6	13.32%
	30	100.00%	45	100.00%

Results based on post-operative gain or
loss of weight.

Note - Only 33.33 per cent of patients not gaining weight were satisfactory compared with 86.65 per cent of those gaining weight.

T A B L E XLVIII

POST-OPERATIVE WEIGHT IN RELATION TO RESULTS
EXPRESSED AS LOSS OR GAIN OVER PRE-OPERATIVE WEIGHT.

	LOSS		GAIN	
	No	PERCENT	No	PERCENT
CURED 29	3	10.36	26	89.64
IMPROVED 20	8	40.00	12	60.00
I.S.Q. 7	4	57.14	3	42.86
FAILURES 19	15	78.94	4	21.06

Post-operative weight based on
results.

Note - (a) "Cures" 10.36 per cent lost weight post-operatively.

(b) "Failures" 78.94 per cent lost weight pre-operatively.

T A B L E X L I X

POST-OPERATIVE DEFICIT IN WEIGHT

	CURED	IMPROVED	I. S. Q.	FAILURES
a: NUMBER OF POUNDS BELOW CORRECT WT.	18.7 lbs.	19.8 lbs.	23.43 lbs.	34.06 lbs.
b: POST-WAR CORRECTION	11.7 lbs.	12.8 lbs.	16.43 lbs.	27.06 lbs.

- Note Post-operative weight deficit
- (a) - Pre-war standards
 - (b) - Post-war correction of -7lbs. for average person.
 - (c) - Degree of weight loss and poor results are parallel.

T A B L E L

POST-OPERATIVE WEIGHT — SEX RATIO

MALES 64				FEMALES 11			
GAIN		LOSS		GAIN		LOSS	
NO.	PERCENT	NO.	PERCENT	NO.	PERCENT	NO.	PERCENT
43	67.2%	21	32.8%	2	18.18%	9	81.81%

- Note - High percentage of weight loss in female group compared with male group - 81.81. per cent to 32.8 per cent

that only 33.33 per cent of those who had lost weight were satisfactory and only 10 per cent cures (Table XLVII). Of those who gained weight 86.65 per cent were satisfactory with 57.77 per cent cures. These figures demonstrate very clearly that gain in weight is accompanied by a much higher percentage of good results, and as Strauss et al 1937 remark, the bodily weight is the closest parallel to the results of the operation in general. An opinion with which we concur.

POST OPERATIVE WEIGHT IN RELATION TO RESULTS -

Table XLVIII. Of the twenty-nine "cured" patients only three or 10.36 per cent had lost weight. As the results became worse the percentage of patients losing weight became greater, so that 78.94 per cent of the failures had lost weight post-operatively. These figures again bring home the truth of Strauss's statement.

Table XLIX shows the post-operative deficit in weight compared with the end result (a) using the pre-war correct weight, and (b) using the post-war correction of minus 7 lbs. We have found that as the results become worse the average weight loss is more marked.

POST OPERATIVE WEIGHT IN RELATION TO SEX -

Table L. Although the number of female patients in this series is small i.e. eleven, yet nine or 81.81 per cent had lost weight as a result of the operation. Of the males only 32.8 per cent

/had

had lost weight post-operatively. Also the actual weight deficit was much greater in the female patients, *vide infra*.

CORRECT WEIGHT -

The correct weights used in this series were obtained from Roses tables. We are unaware of any tables that have been published in the U.K. since 1939. However, most of the large insurance companies in this country now allow a loss of 7 lbs. over the pre-war correct weight, assuming that in general the adult population has lost half a stone as the result of the war. In spite of this allowance of 7 lbs. the patients with partial gastrectomy were still 15.6 lbs. underweight. We were so impressed by the malnutrition of these patients that we investigated the weights of two hundred consecutive patients admitted to the Medical Out-Patient Department. These patients were all suffering from organic disease - cases of obesity were excluded. On the average the males were 11.7 lbs. below their pre-war correct weight, compared with 22.1 lbs. for the patients with partial gastrectomy. The female patients were 8 lbs. below pre-war correct weight compared with 32 lbs. for the females with partial gastrectomy. Again the average for the group of patients with partial gastrectomy was 23.6 lbs. below correct weight compared with 10.1 lbs. for the Medical Out-Patient Department patients. Using the pre-war weight standards only four patients were above their correct weight, two had

been operated on for a duodenal ulcer and gained 2 lbs. each, while the other two had had gastric ulcers and gained 2 and 14 lbs. respectively. Using the post-war correction ten patients were above their correct weight. These included five cases of duodenal ulcer who were 9, 9, 2, 6 and 4 lbs. overweight, and five cases of gastric ulcer 21, 3, 2, 8 and 1 lb. above their correct weight.

In the light of this finding of such a high percentage of patients being below their correct weight we undertook intensive studies in three patients whom we felt were typical examples of post-gastrectomy malnutrition.

Three patients constitute a very small number, but each patient was in hospital for 4 - 8 weeks for these investigations. When it is remembered that a nitrogen balance done under a period of two weeks is quite useless it will be appreciated that the full investigation of these patients is no mean problem.

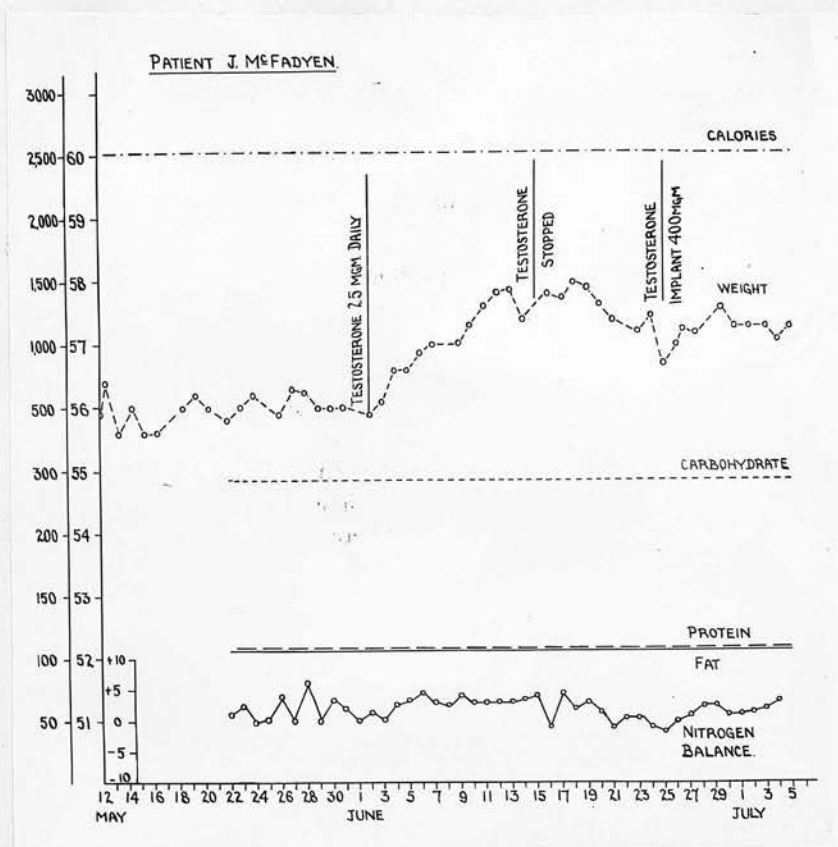
INVESTIGATION OF FAILURE TO GAIN WEIGHT

Case 1 - James McFadyen aet 57 - Partial gastrectomy for a gastric ulcer in December 1945. At the time of operation he was 9 stone 7 lbs. at the time of investigation 8 stone 12 lbs; correct weight 12 stone. Since the operation he had felt very weak and had taken a light surface job whereas pre-

/ operatively

T A B L E L I

(a)



- Note - 1. Failure to gain weight on 2,500 calories and 109 gms. of protein per day.
2. Testosterone caused slight increase in weight +4 lbs. Very little improvement in nitrogen balance +2 to +3.2 gms. daily.

operatively he was employed at the pit face. Associated with these symptoms was upper abdominal distension after meals. There were no symptoms of hypoglycaemia, diarrhoea or vomiting.

Investigations - Hb. 100 per cent. R.B.C. 6,130,000; C.I. 0.8; Plasma proteins - Albumin 3.50 gms. per cent; Globulin 2.53 gms. per cent. total protein 6.03 gms. per cent. Stool fats - total fat 19 per cent, split fat 75 per cent, unsplit fat 25 per cent. Test meal - achlorhydria B.M.R. -2. .

From our findings it was obvious that the patient was absorbing fat normally. As we have noted in Chapter XVI the absorption of carbohydrates in these patients is adequate; in spite of this and a 2,500 calorie diet he failed to gain weight. The normal B.M.R. ruled out excessive metabolism as the cause of failure to put on weight. It seemed obvious, therefore, that we should investigate the nitrogen metabolism. On a fixed diet of 2,500 calories - carbohydrates 287 gms. protein 109 gms. and fat 106 gms. - a nitrogen balance was carried out, Table LI(a). On this regime the stool nitrogen was 2 gms. daily and the nitrogen balance + 2 gms. daily. In spite of this positive nitrogen balance and adequate calories he failed to gain weight.

Testosterone 25 mgm. daily was commenced on 2nd June and had the effect of increasing the weight by 4 lbs. in one week at which time the

/ nitrogen

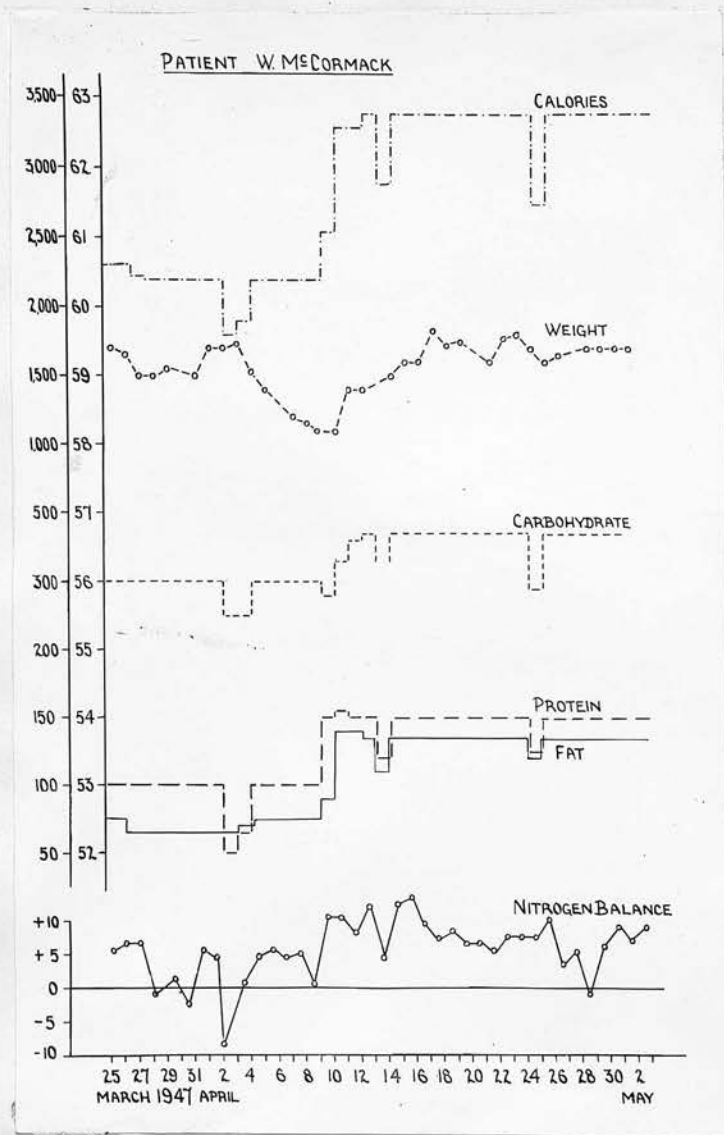
nitrogen balance had increased to $+3.2$ gms. daily by June 9th. Testosterone was stopped on 9th June when his nitrogen balance fell to zero, and he commenced to loose weight. By 15th June his weight had fallen 2 lbs. and his nitrogen balance remained zero. On 25th June he was given a 400 mgm. implant of testosterone following which his nitrogen balance became steady at $+2$ and his weight remained relatively constant.

Discussion - This patient had lost 9 lbs. since operation and was 44 lbs. below his correct weight. In spite of normal absorption of fat, carbohydrate, nitrogen and a normal B.M.R. he failed to gain weight on a diet of 2,500 calories. The stool nitrogen of 2 gms. daily was well within normal limites showing that the absorption was normal - however he excreted some 13 gms. daily in his urine, leaving a positive nitrogen balance of $+2$ gms. daily.

The possible causes of this excessive excretion of nitrogen in the urine were two. Either he was forming it into tissue protein which was being rapidly broken down, or he was failing to use it in the manufacture of tissue protein and excreting it as soon as it was absorbed. If the former had been the cause then his B.M.R. should have been abnormally high - it was -2 . We therefore postulated the failure of utilisation of nitrogen as the cause and it was on this basis that we gave testosterone. Testosterone is known

T A B L E L I

(b)



- Note - 1. Failure to gain weight on 2,300 calories with 100 grs. of protein per day and nitrogen balance of +5.
2. Failure to gain weight on 3,500 calories with 150 grs. of protein per day and nitrogen balance of +8.

to have a nitrogen holding effect. This drug increased the nitrogen balance slightly to +3.2, but its action was much less than we expected and his gain in weight disappointing. Why this patient should have failed to utilise more fully his absorbed nitrogen for the building of body tissues we do not know.

Case II - William McCormack - aet 44. Partial gastrectomy nine months previously for a duodenal ulcer. Pre-operatively he was employed as a miner at the pit face, post-operatively he was so weak that after an eight hour shift of watching an electric pump he was completely exhausted. In addition he suffered from post prandial hypoglycaemia, sweating, tachycardia and dizziness. Pre-operative weight 10 stone, present weight 9 stone 8 lbs. correct weight 11 stone 6 lbs. (LI(b))

Investigations - Hb. 118 per cent. R.B.C. 5,150,000; C.I. .91; W.B.C. 9,400. Plasma proteins - Albumin 3.65 gms. per cent; Globulin 1.6 gms. per cent; total protein 5.25 gms. per cent. Test meal - histamine achlorhydria. Blood sugar 84, 146, 166, 112, 62, 68 and 76 mgm. per cent. B.M.R. +2. Fat balance normal.

Nitrogen Balance - On a diet of 2,300 calories daily with 100 gms. of protein he was in positive balance +5. On April 2nd and 3rd he was given protein hydrolysate 50 gms. intravenously in order to determine whether or not we could increase his utilisation of protein - the diet on

/ these

these two days was 1,750 calories, but his nitrogen balance fell to -8. During the next week he lost 2 lbs. in weight although his nitrogen balance was positive +5. The diet was then increased to 3,500 calories with 150 gms. of protein. This resulted in an increase in nitrogen balance of +8 but no improvement in weight.

Discussion - As in Case 1 this patient had lost weight since operation with a normal B.M.R. and fat balance. In spite of a positive nitrogen balance of +5 - 8 and on a very adequate diet of 3,500 calories he failed to gain weight. His stool nitrogen was less than 1 gm. daily and, therefore, as we anticipated intravenous protein hydolysates did not improve his nitrogen balance or weight. Admittedly on the two days on which he received this therapy his calorific intake was 1,750 calories only.

This patient was again absorbing nitrogen normally, was in strong positive balance and yet failed to gain weight. The somewhat low figure of total proteins in this case, 5.25 gms. per cent, may also be explained by his inability to use the absorbed amino acids in the manufacture of plasma proteins.

Case III - William Heatly aet 32. Partial gastrectomy for duodenal ulcer nine months previously. Since the operation has felt well and gained weight. Pre-operative weight 9 stone 4 lbs; present weight 10 stone; correct weight

11 stone 6 lbs.

Investigations - Hb. 110 per cent; R.B.C. 5,780,000; C.I. .95; W.B.C. 6,600. Plasma proteins Albumin 4.31 gms. per cent. Globulin 2.65 gms. per cent. Total plasma proteins 6.96 gms. per cent. Test meal - histamine achlorhydria, B.M.R. +6.

A nitrogen balance was again carried out, this time over a fourteen day period. On a diet of 2,300 calories and 80 gms. of protein he gained weight and was in positive balance of +3 gms. daily - weight gained 4 lbs. in two weeks.

There was no significant difference in this patient's investigations or nitrogen balance from that of the other two. Why he should gain weight on a nitrogen balance which was no less positive and on less calories than the other two patients we do not know.

- Conclusions
1. Patients following resection are prone to be underweight;
 2. In spite of a positive nitrogen balance and an adequate calorific intake some fail to gain weight while others, in less positive balance and on a lower calorific intake gain weight;
 3. The failure to gain weight is presumably due to failure to utilise the ingested protein in the manufacture of body tissue;
 4. Testosterone has little effect on improving either the weight or the nitrogen balance in these patients; and
 5. The cause of the failure to utilise protein has not been explained.
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SERUM CALCIUM FOLLOWING PARTIAL GASTRECTOMY

The absorption of calcium occurs normally only in the jejunum and is facilitated by the presence of an acid medium. Should the reaction be alkaline the insoluble calcium phosphate $\text{Ca}_3(\text{PO}_4)_2$ and calcium carbonate CaCO_3 are formed, and less absorption takes place. If fat is incompletely absorbed it unites with calcium in the intestine to form insoluble soaps, thus leading to calcium loss. Other factors being equal increased ingestion of calcium leads to increased absorption. Finally Vitamine D, the action of which is not yet established, is essential for calcium absorption.

The fact that calcium is absorbed from the jejunum in an acid medium was the basis of some experimental work by Ivy. In 1940 he reported the occurrence of osteoporosis following partial gastrectomy in puppies two or three months of age. The decalcification resulted in gross bony deformities and spontaneous fractures of the limb bones. There was no evidence of rickets. Ivy also cites an instance of osteoporosis following a gastric resection in a human being. The explanation put forward by this author is that the absence of hydrochloric acid plays a part in the mechanism of osteoporosis since the presence of hydrochloric acid renders calcium more soluble and available for absorption. Also the loss of the stomach's trituration and reservoir functions encourages the rapid passage of food through the

upper intestine where most calcium is normally absorbed.

The post prandial acidosis, of achlorhydric patients, due to the secretion of alkaline intestinal juices, and the absence of acid secretion by the stomach may interfere with the normal deposition of calcium and the bones therefore become osteoporotic. A further possible factor postulated by Ivy is the hyperplasia of red marrow, in attempting to prevent post gastrectomy anaemia may encroach on the osseous bone.

In the present series we have found little support for Ivy's postulations. Of the seventy-five patients investigated all except three had serum calcium values of between 9 and 10.5 mgm. per cent (normal 9 - 11 mgm. per cent) with a mean of 9.7 mgm. per cent. The presence or absence of free hydrochloric acid in the post-operative test meal likewise bore no relationship to the serum calcium. In the achlorhydric cases the average serum calcium was 9.72 mgm. per cent and in those with free acid 9.65 mgm. per cent.

The serum calcium is analogous to the plasma proteins in that it is the "last line of defence" so to speak and will remain above the critical level in order to perform its vital functions in neuro-muscular junctions, cardiac contractions and blood clotting, at the expense of profound decalcification of bones. Hence unless the decalcifications were extreme one would not expect a fall in the serum calcium. If, however, in

spite of their normal serum calcium levels these patients had been osteoporotic, and therefore their bones prepared for calcium which was not forthcoming, the alkaline phosphatase level would have been raised by osteoblastic activity - such was not the case. The alkaline phosphatase was within normal limits (6 - 10 King-Armstrong Units) in all cases. There was no radiological evidence of osteoporosis in the fifteen patients on whom this examination was carried out.

The presence of decalcification, should it occur, must do so very slowly. In this series in which the follow up period was more than 5 years in 18.7 per cent of patients, there was no evidence of a fall in serum calcium parallel with the post-operative period.

PATIENTS WITH LOW SERUM CALCIUM -

Case 1 - Female aet 33 - History - Partial gastrectomy done twenty months ago because of recurrent perforation of a duodenal ulcer. Three perforations in the three years preceding partial gastrectomy. No history of pain or vomiting apart from that accompanying the perforations. Five children all breast fed during the seven years prior to partial gastrectomy. The patient lived in poor circumstances on a diet very low in calcium.

INVESTIGATIONS - Serum calcium 6.1 mgm. per cent (checked twice). Free acid in test meal 40 units. No clinical evidence of tetany. Plasma proteins - Albumin 3.95 gms. per cent. Globulin 1.88 gms. per / cent

cent - total 5.83 gms. per cent.

Blood counts - Hb. 58 per cent. R.B.C. 4,600,000; C.I. .63; P.C.V. 35 per cent; W.B.C. 5,000.

Stools - Total fat 20 per cent; split fat 75 per cent; unsplit fat 25 per cent. Benzidene negative. Menstrual periods normal.

This patient showed the lowest serum calcium in the series. We feel that partially gastrectomy as the causative factor is very doubtful. She lived on a poor diet before and after the operation as is witnessed by her microcytic hypochromic anaemia. In addition she had borne and breast fed five children in seven years. We feel that her dietetic and obstetrical history full accounts for her low serum calcium.

Case II - Male aet 50 - Partial gastrectomy twenty-four months previously because of recurrent perforation of a duodenal ulcer, twenty, fifteen and three years pre-operatively. Following each perforation the patient was symptom-free for between twelve and eighteen months on each occasion. Dietetic history fairly good.

INVESTIGATIONS - Serum calcium 8 mgm. per cent. No free acid in non-histamine test meal. Forty units of free acid in histamine test meal. Plasma proteins - Albumin 3.79 gms. per cent; Globulin 1.75 gms. per cent - Total 5.54 gms. per cent.

Blood counts - Hb. 97 per cent. R.B.C. 4,840,000; C.I. 1; P.C.V. 44 per cent. W.B.C. 6,000.

Stool - Benzidene negative - macroscopic examination negative.

The low serum calcium is not so easily explained in this case. There was no evidence of malabsorption from the macroscopic examination of the stool. The calcium balance was also normal. Radiologically the bones showed no evidence of decalcification. The serum alkaline phosphatase was 8 units. As free acid was only present after histamine stimulation it might be argued that the normal stimulus to acid secretion was not sufficient resulting in achlorhydria with ordinary food. However, the normal calcium balance excludes this factor.

Case III - Male aet 44. Partial gastrectomy done eight months previously because of pain and stenosis. Thirty year history of duodenal ulcer. One perforation twenty years before partial gastrectomy. Dietetic history good.

INVESTIGATIONS - Serum calcium 8.6 mgm. per cent. No free acid in histamine test meal. Plasma Proteins - Albumin 3.65 gms. per cent. Globulin 1.6 gms. per cent - Total 5.25 gms. per cent.

Blood counts - Hb. 100 per cent. R.B.C. 5,200,000; C.I. 1; P.C.V. 46 per cent. W.B.C. 8,200.

Stool - Benzidene negative. Macroscopic examination negative.

The serum calcium in this man's case is only slightly below normal. Again all examinations

/ were

were negative, and it is difficult to explain the low serum calcium.

DISCUSSION OF ABOVE CASES -

In discussing the above three cases individually we purposely omitted to discuss the plasma proteins. The total plasma proteins in these three cases are all below the normal value of 6 - 8 gms. per cent. This reduction is in the same proportion for albumin (normal 4.5 gms. per cent) and globulin (normal 2.5 gm. per cent) so that the albumin-globulin ratio of these patients is normal 1.7 - 1. The plasma proteins in these three patients was slightly below the average for the series as a whole - this applies to albumin, globulin and total proteins. Unfortunately the ionisable and non-ionisable calcium fractions were not determined in these cases. However, since there was no evidence of tetany we may assume that the reduction was chiefly in the non-ionisable fraction. Since the non-ionisable calcium is transported by albumin it might be postulated that the lower serum calcium corresponds with the reduction in albumin.

This, however, is not in keeping with the findings in other cases. Many patients in the series had lower total proteins, and lower albumin levels with calcium readings of between 9.5 and 10.5 mgm. per cent. This would seem to exclude any reduction in plasma proteins as the cause of the low serum calcium. As was stated previously

the reduction in calcium may be explained in the first patient's case by her poor diet and obstetrical history. The two male patients, however, afford no such basis.

There is one interesting feature of these three patients. All had had one or more perforations prior to partial gastrectomy. The two with the lowest serum calcium readings had each had three perforations. As was remarked previously one of these patients was a woman, and three perforations is quite extraordinary in a female patient. Is it possible that these patients had lower serum calcium readings before partial gastrectomy? Is there any relationship between the presence of a low serum calcium and the tendency to perforate? We have been unable to find any reference to this problem in the literature. We have one patient, not included in this series owing to his defaulting when asked to come in for investigation, who, some four years prior to partial gastrectomy for duodenal ulcer had idiopathic tetany with serum calcium levels of 5 - 6 mgm. per cent. During this period he twice perforated. It is not very unusual for patients with duodenal ulcer to perforate twice, but we feel the low calcium and recurrent perforation in this patient might throw light on the three patients of the present series.

HAEMATOLOGY FOLLOWING PARTIAL GASTRECTOMY

The work of Castle et al (1939/2), (1930) and (1931) demonstrated beyond doubt that a factor in the gastric secretion was directly concerned with the normal maturation of red blood cells. This fundamental factor in gastric juice, the so-called intrinsic factor, is essential to the maintenance of normal blood formation, and its absence is known to be directly responsible for the development of primary Addisonian anaemia. For the most part cases of so-called pernicious anaemia show a lack of hydrochloric acid secretion as well as loss of the intrinsic haemopoietic factor. But of the two factors, the latter is the more fundamental, inasmuch as there are rare but authenticated cases of pernicious anaemia unassociated with complete achlorhydria.

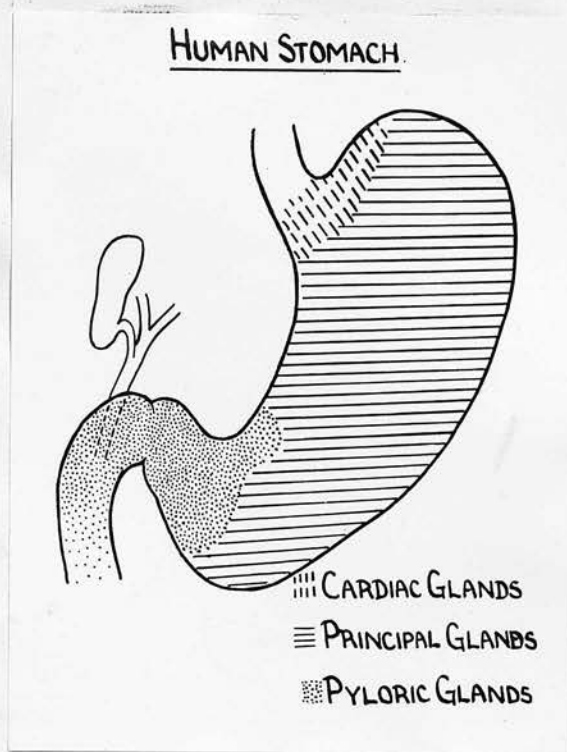
The establishment of this important function of the stomach has provided us with a much greater understanding of the problems of haemopoiesis, and must of necessity enter into any consideration of the effects of partial gastrectomy. In the absence of most of the stomach what effects must one anticipate on the problem of normal blood formation? Such a consideration underlies a large amount of careful investigation directed at establishing the site of formation of this anti-anaemic factor of Castle.

Castle (1929) demonstrated that there is

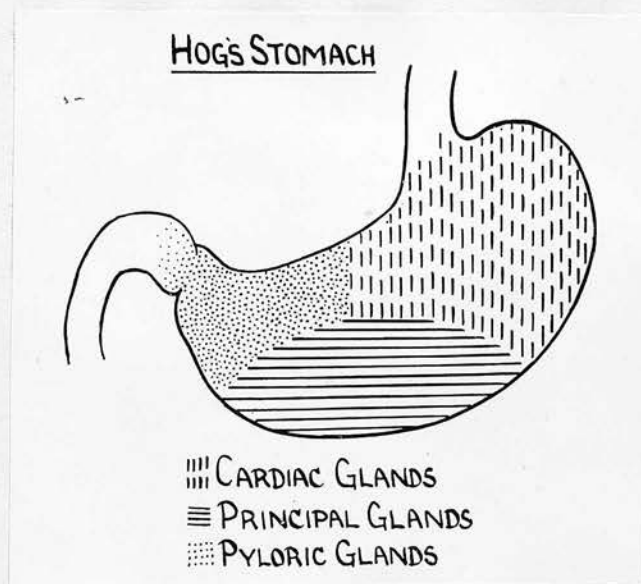
found within the normal stomach during the digestion of beef muscle some substance capable of promptly relieving the anaemia of patients suffering from pernicious anaemia, and that this substance was absent from the gastric secretion of such patients. He, apparently, showed that this intrinsic factor could not be demonstrated in normal human duodenal contents, nor in saliva when either secretion was incubated with beef muscle. He concluded that this active constituent of normal stomach is in all probability secreted by the gastric mucosa. This was the first demonstration of a relationship between the stomach and bone marrow. His studies were made entirely on the gastric secretions of human beings.

Since these studies various investigators have sought to obtain more precise information as to the site of formation of this intrinsic factor. Sturgis and Isaacs (1929), Conner (1930) and Wilkinson (1931) showed that dried hog's stomach was efficacious in the treatment of pernicious anaemia. Meulengracht (1934/2), (1935/4) carried out more detailed experiments using cardiac fundal, pyloric and duodenal extracts from swine. Maximal activity was noted in the pyloric and duodenal extracts, some in the cardiac, and nil in the fundal. He concluded that the glands of the cardia and pylorus and Brunners glands in the duodenum are functionally identical and that

D I A G R A M VII
(a)



(b)



Distribution of secretory glands in (a) human and (b) hog, stomach - note difference. The basis of Meulengracht's error was in assuming the distribution to be similar.

in man pernicious anaemia is due to failure of the pyloric gland organ.

Meulengracht's mistake was in assuming that the distribution of the glands secreting the intrinsic factor had a similar topographical distribution in man and swine, Diagram VII. Later, in autopsy studies Meulengracht (1939) found as had Faber and Bloch (1900) that in patients with pernicious anaemia the greatest atrophy is in the fundal glands, whereas the pyloric glands and Brunners glands are well preserved. Such a finding was a direct variance with those in the pig and correlated with the fact that Castle demonstrated the maximum response to pernicious anaemia was obtained from fundal not pyloric mucosal extracts in man. Uotilia (1938) demonstrated a satisfactory response in pernicious anaemia to the use of powdered ileum, duodenum, and jejunum, the first preparation being the most potent. Brown (1934) found that in patients suffering from pernicious anaemia, who had come to autopsy, in addition to fundal atrophy there was what he deduced to be widespread enteritis. Jacobson (1939) making a special study of the argentaffine cells which normally occur in the cardia, pylorus, duodenum, small intestine, colon, and appendix, noted the complete or almost complete absence of these cells in patients dying from pernicious anaemia. He suggested the possibility that these cells are responsible for the secretion of the intrinsic / factor

factor. Proof, however, is still lacking in view of Castle's original failure to produce a remission in patients with pernicious anaemia whom he fed on a mixture of beef muscle incubated with normal duodenal contents. With these findings in mind, in spite of complete proof it is obvious on the basis of animal experimentation that the development of primary Addisonian anaemia in man as a sequel to partial or total gastrectomy is rarely to be expected. Clinical reports are fully in accord with such an assumption.

MACROCYTIC ANAEMIA FOLLOWING PARTIAL GASTRECTOMY

Moynihan (1911) reported a successful removal of the entire stomach for cancer in a patient whom he was able to follow over three years. A severe anaemia developed two years after operation which responded to treatment temporarily but subsequently recurred and ended in the death of the patient. At post mortem there was no evidence of malignancy and presumably the anaemia was the cause of death. No blood counts were done and the nature of anaemia therefore not established.

Sporadic instances of macrocytic anaemia have been reported from time to time. The first case which really brought this possibility home was one described by Hartman at the Mayo Clinic in 1921. The patient developed macrocytic anaemia eighteen months after total gastrectomy for a gastric carcinoma.

In 1922 Campbell and Conybeare reported a case

of Addisonian anaemia following gastro-enterostomy. Rowlands and Simpson (1932) reviewing the literature to date found records of fifteen cases of macrocytic anaemia following gastro-enterostomy, total and partial gastrectomy, and added two cases of their own. Goldhamer (1933) collected twenty-three cases from the literature including one of his own. Jones (1940) stated that only ten more cases had been reported since Goldhamer's review in 1933. In 1939 Sturgis and Goldhamer reported three cases from the Simpson Memorial Hospital, New York. In 1941, Meyer, Schwartz and Weissman collected fifty-four cases of what they considered to be authentic cases of pernicious anaemia following total gastrectomy.

The rarity with which Addisonian anaemia develops as a sequel to partial gastrectomy has been stressed by the figures of the following authors. Walton (1934) no cases following 800 partial gastrectomies. Lake (1929) no cases in over 300 partial gastrectomies. Ogilvie (1935) none in 140. Watson (1947) none in 127 cases. Strauss (1938) no cases in 28 partial gastrectomies with a very careful follow-up. In the present series of 75 cases there was not a single instance of macrocytic anaemia. Realising, as has been pointed out by Witts (1930), that one may find a macrocytic anaemia with a low colour index, we checked the M.C.V. in all cases and in none was it more than 94. Rowlands and Simpson state that the macrocytic anaemia following partial gastrectomy

is more akin to that which results from steatorrhoea than to true Addisonian anaemia, that the indirect Van Den Burgh reaction is usually within normal limits and megaloblasts are less frequently seen in the peripheral blood. Hamilton Fairley, and Kilner (1931) reported an interesting case of macrocytic anaemia following a gastro-colic fistula - on closure of the fistula the anaemia disappeared.

In reviewing the reported cases of macrocytic anaemia following partial gastrectomy, we have been impressed by the long post operative interval before the onset of the anaemia. Very few cases are reported with a post operative period of less than two years, the majority being between five and ten years. Should we discontinue administration of liver extract or folic acid to a patient with pernicious anaemia for a period of three or four months they would become anaemic. If we attribute the post operative macrocytic anaemia of some patients to a mechanism similar to that of pernicious anaemia why does it take five to six years for the anaemia to develop instead of three to four months? It may be that, as Jacobson postulates, these patients secrete intrinsic factor from the rest of their intestine and this may be only slightly below the amount actually required, hence the slow onset. Castle believes that the store of anti-pernicious anaemia factor in the liver is at least enough for one

T A B L E L I I

DISTRIBUTION OF CASES ACCORDING TO HAEMOGLOBIN AND RED BLOOD COUNT

	HAEMOGLOBIN PERCENTAGE								
	40-49%	50-59%	60-69%	70-79%	80-89%	90-99%	100-109%	110-120%	120-129%
No. OF CASES	1	2	1	2	4	11	28	23	3
% OF TOTAL	1.33%	2.66%	1.33%	2.66%	5.33%	14.66%	37.33%	30.66%	4.00%

RED BLOOD COUNT

	RED CELL COUNT IN MILLIONS PER C.M.M.								
	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-5.5	5.5-6.0	6.0-6.5
No. OF CASES	—	—	—	2	9	14	36	10	3
% OF TOTAL				2.66%	12.00%	20.2%	48.44%	13.33%	4.00%

Post-operative Haematology

Note - 1. 21 patients with Hb. less than 100 per cent.

2. 25 patients with R.B.C. less than 5,000,000.

year. These two factors may then account for the tardy onset of macrocytic anaemia when it does occur.

FIGURES FOR THE PRESENT SERIES IN DETAIL

The blood investigations in the present series includes (1) Haemoglobin estimation; (2) Red cell count; (3) Colour index; (4) P.C.V.; (5) M.C.V.; (6) M.C.H.C.; (7) W.B.C.; and (8) Blood film.

DEFINITION OF ANAEMIA - If we accept the standards of Whitby and Britton (1940) a patient with values below the following must be labelled anaemic:

Lowest normal for male	- Hb.	- 100 per cent
	R.B.C.-	5,000,000
Lowest normal for female	- Hb.	- 85 per cent
	R.B.C.-	4,500,000

We feel that such a standard is very high and that patients with readings below these often suffer from no symptoms attributable to their blood counts.

DISTRIBUTION OF HAEMOGLOBIN AND RED BLOOD COUNTS -

Table LII - Only twenty-one patients or 28 per cent had a haemoglobin of below 100 per cent, the remaining fifty-four patients, i.e. 72 per cent had haemoglobin of over 100 per cent. Using Whitby and Britton's criteria one of the female patients had a haemoglobin of 95 per cent and therefore the number of patients with anaemia was only twenty or 26.66 per cent.

The distribution of the R.B.C. is comparable.

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T A B L E L I I I

PATIENTS WITH HAEMOGLOBIN LESS THAN 100%

HAEMOGLOBIN LEVEL	NAME	SEX	AGE	SITE OF LESION	POST OP PERIOD IN MONTHS	FA IN NON HISTAMINE TEST MEAL	FA IN HISTAMINE TEST MEAL	HAEMO-GLOBIN MILLIONS	R.B.C. IN MILLIONS	C.I.	PCV	
90-99%	PRATT	M	24	DU.	6 MTHS	0	0	98.0	4.60	1.05		
	FORSTER	M	37	DU.	36 "	10	22	90.0	4.70	.94	42	
	PENDRIGH	M	48	DU.	46 "	0	0	90.0	5.55	.81	44	
	TONNER	M	57	DU.	36 "	0	0	96.0	4.75	1.0	45	
	WATSON	M	30	DU.	43 "	0	8	95.0	4.49	1.06		
	EDMINSON	M	50	DU.	23 "	0	40	97.0	4.80	1.01		
	CLARK	M	52	DU.	23 "	0	0	98.0	5.01	.97	47	
	MOIR	M	60	G.U.	18 "	0	0	96.0	4.76	1.01	44	
	HANNAH	M	45	G.U.	109 "	0	32	98.0	4.60	1.05		
	ASHBROOKE	F	58	G.U.	72 "	0	0	93.0	4.42	1.05		
	LAPSLEY	M	44	STOMA	18 "	0	0	95.0	4.91	1.03		
	80-89%	FORBES	M	59	G.U.	12 MTHS	0	0	86.0	4.92	.96	47
		MOWAT	M	44	G.U.	10 "	0	40	82.0	4.60	.90	
LYNCH		F	46	G.U.	23 "	0	0	80.0	4.00	1.0	40	
AITKEN		F	47	STOMA	25 "	0	0	82.0	4.47	.96	38	
70-79%	WOOLARD	M	53	G.U.	40 MTHS	0	28	70.0	4.70	.74	35	
	LINTON	F	56	G.U.	96 "	0	0	70.0	3.80	.92	34	
60-69%	DOBSON	M	42	DU.	108 MTHS	0	0	65.0	5.00	.65	38	
50-59%	LEE	F	34	DU.	24 MTHS	20	30	58.0	4.60	.63		
40-49%	ROBERTSON	M	59	G.U.	60 "	0	0	55.0	3.90	.70	35	
	WINTON	F	59	G.U.	80 MTHS	0	0	48.0	4.75	.51	285	

Details of 21 patients with post-operative haemoglobin of less than 100 per cent.

The number with a R.B.C. of below 5,000,000 being twenty-five patients, or 33.33 per cent. Of these, two were female patients with red cell counts of between 4,500,000 and 5,000,000 and are therefore not included as anaemic by Whitby and Britton's standards. As anaemia is usually discussed on a basis of haemoglobin rather than red blood counts, we have adopted this standard in the following discussion.

Of the twenty anaemic patients ten, including the one female, had haemoglobin levels of between 90 and 99, four between 80 and 89, and six below 80 per cent. Mild anaemia includes patients with a haemoglobin of between 80 and 100 per cent and severe anaemia those with a haemoglobin of under 80 per cent.

The details of these patients are given in Table LIII.

MICROCYTIC ANAEMIA

The first recorded case of anaemia following gastrectomy was that by Deganello in 1900 who reported a severe secondary anaemia following gastrectomy in a woman of 48. Three months after the operation her haemoglobin was 65 per cent; R.B.C. 3,670,000; C.I. .88. Since this first report most investigators of the results of this operation have paid special attention to this complication of partial gastrectomy.

Before discussing the incidence of this complication, it is of interest to review the

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experimental work on the subject.

Ivy, Ritcher, Meyer and Greengard (1934) reported the absence of pernicious anaemia among dogs that had been subjected to partial gastrectomy, some as long as ten years. Ivy (1940) noted that gastrectomised dogs occasionally developed microcytic anaemia. The anaemia was more severe if pregnancy, severe infection or dietary deficiency supervened. Ivy attributed the anaemia to a deficiency in the ability to regenerate haemoglobin. The work of Dragstedt and his associates (1933 and 1935) indicates that the gastrectomised dog remains anaemic on a stock diet but responds well when excess of iron is given by mouth.

REVIEW OF PUBLISHED RESULTS

Great discrepancy exists as to the incidence of anaemia (non-macrocytic) following partial gastrectomy. The type of anaemia is usually microcytic hypochromic, but instances of normocytic and normochromic varieties have been reported by Rekers, Pack and Rhoads (1943) and Pack and McNeer (1943) following total gastrectomy. Microcytic anaemia is, however, by far the commonest type.

The incidence of this complication in the published results has varied greatly. High percentages were quoted by Still (1936) who found 19 out of 22 patients to have a haemoglobin of less than 85 per cent. G.G. Taylor et al (1928) reported anaemia in 23 out of 52 cases. Morley

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and Roberts (1928) 16 out of 42 and Larsen (1934) 31 out of 84. At the other end of the scale are the figures of Berg (1930) who reported not a single instance of anaemia following 400 partial gastrectomies. Between these extremes are the figures of Rosenthal and Abel (1933) who reported 15 cases of anaemia after 117 partial gastrectomies, and Watson (1947) 14 cases out of 127. The figure of 20 out of 75 or 26.33 per cent for the present series would seem to be about the average.

ILLUSTRATIVE CASES - TABLE LIII

Case I - Dobson - Male aet 42. Ten year history of duodenal ulcer symptoms prior to partial gastrectomy which was carried out 108 months ago. The patient was well until 36 months ago when he began to complain of weakness and loss of energy, since when the symptoms have become more marked.

On admission his haemoglobin was 65 per cent; R.B.C. 5,000,000; C.I. .65. No free acid in test meals. There was marked koilonychia, atrophy of the tongue, cheilosis and mild splenic enlargement. After three months medication with ferrous sulphate grs. 3 T.I.D., nicotinamide 50 mgm. daily, and ascorbic acid 50 mgm. T.I.D. his haemoglobin was 100 per cent, cheilosis absent and spleen no longer palpable. The koilonychia and glossitis, however, remained unchanged.

Case II - Mrs. Winton aet 59 - Partial gastrectomy for a gastric ulcer 80 months ago. Asymptomatic until 24 months ago when she began to complain of

/ increasing

increasing dysponia, loss of weight, lethargy, sore tongue and dysphagia. On admission her tongue was atrophic and intensely red around the margins, marked cheilosis and koilynychia. The test meals contained no free acid. Blood counts haemoglobin 48 per cent; R.B.C. 4,750,000; C.I. .51; P.C.V. 28.5 per cent. Following three months therapy with ferrous sulphate gr. III T.I.D. nicotinamide 50 mgm. daily and ascorbic acid 50 mgm. T.I.D. she had gained 14 lbs. in weight, her tongue less red and not painful, her dysphagia gone but the koilynychia still present, her haemoglobin was 110 per cent.

TIME OF ONSET OF ANAEMIA

It is first necessary to ascertain whether any of the patients were anaemic before operation, and the present condition of anaemia a continuation of that state. It is curious that only one case with a pre-operative history of haematemesis and anaemia appear in the "severely anaemic group", and since the relation of the pre and post operative condition of the blood cannot be satisfactorily elucidated they are not considered in this paragraph. From a scrutiny of the pre-operative notes there is no evidence that any of the patients went to the operation in an anaemic state. Unfortunately, however, pre-operative blood examinations were only available in a very limited number of cases.

In the absence of continuous observations and frequent blood counts it is obviously impossible

T A B L E L I V

SEX RELATIONSHIP OF POST OPERATIVE HAEMOGLOBIN

HAEMOGLOBIN	64 MALES		11 FEMALES	
	No.	PERCENT.	No.	PERCENT
LESS THAN 80%	3	4.68%	3	27.27%
80-100 %	12	18.75%	3	27.27%
MORE THAN 100%	49	76.67%	5	45.45%

Note - High percentage of females with post-operative Hb. less than 100 per cent, 54.54 per cent, compared with males 23.43 per cent.

to state with accuracy the exact time of onset of the anaemia after operation. This does not exclude the possibility of its existence in the earlier post-operative period before the cases came under observation, especially as the onset may be very insidious, and other prominent symptoms occupy the attention of the sufferer. From a scrutiny of the whole series the broad generalisation can be made that the anaemia is insidious in its onset, and if untreated, slowly progressive in its course. This would account for the fact that in the present series the cases examined at long intervals after operation were as a rule the most anaemic.

The average post-operative period of the non-anaemic patients in this series was 28.6 months, for those with haemoglobin between 80 and 100 per cent 41 months, for those with haemoglobin of under 80 per cent 68 months. This would seem to indicate that following partial gastrectomy the incidence and severity of the anaemia parallels the post-operative period - an observation made by Hartfall (1934).

SEX INCIDENCE OF ANAEMIA

It has been a universal finding by investigators of post gastrectomy anaemia that the incidence is invariably greater in females than males, especially in middle life. This fact is shown in the present series, Table LIV, where only 4.68 per cent of males were severely anaemic compared with 27.27 per cent of females. Whereas

T A B L E IV.

RELATIONSHIP OF ACHLORHYDRIA TO ANAEMIA				
HAEMOGLOBIN	ACHLORHYDRIA NON-HISTAMINE TEST		ACHLORHYDRIA HISTAMINE TEST	
	NUMBER	PERCENT	NUMBER	PERCENT
OVER 100% 54	36	66.66%	32	59.30%
80-100% 15	14	93.33%	10	66.66%
UNDER 80% 6	5	83.33%	4	66.66%

- (a) Non histamine test - Higher incidence of achlorhydria in anaemic patients, 88.33 per cent to 66.66 per cent.
- (b) Histamine test - achlorhydria only slightly more prevalent in anaemic patients, i.e. 66.66 per cent to 59.30 per cent.

76.67 per cent of males had a haemoglobin of 100 per cent or over compared with 45.45 per cent of females.

RELATIONSHIP OF ACHLORHYDRIA

TO POST-OPERATIVE ANAEMIA

The exact mechanism of the digestion and absorption of iron is not known. Most authorities believe that the main absorption occurs in the duodenum and upper jejunum. The presence of free hydrochloric acid aids the absorption of iron by liberating it from combination with other complexes in the food (Minot 1936), and probably by changing the ferric to ferrous salts which are more readily absorbed (Heath 1933).

The fact that anaemias of all types are more common in achlorhydric than in normal persons has been stressed by Oliver and Wilkinson (1933). Minot also points out that excess of mucus often present with achlorhydria can firmly absorb iron, and thus interfere with its absorption. For the above reasons he believes that achlorhydric patients require a greater daily intake of iron containing food to prevent anaemia, and similarly larger doses of iron in the treatment of established anaemia.

The relationship of achlorhydria to the post-operative haemoglobin is shown in table LV. In the non histamine test meal we found the incidence of achlorhydria to be 93.33 per cent in the mildly anaemic and 83.33 per cent in the severely anaemic compared with 66.66 per cent in the non-anaemic patients. On the basis of achlorhydria

/ following

T A B L E LVI

SITE OF LESION IN RELATION TO ANAEMIA

HAEMOGLOBIN	DUODENAL 40		GASTRIC 27		STOMAL 8		
	NO	PERCENT	NO	PERCENT	NO	PERCENT	
80-99%	7	17.5%	6	22.22%	2	25%	15
LESS THAN 80%	2	5.0%	4	14.81%	0	0%	21
TOTAL	9	22.5%	10	37.03%	2	25%	

Post-Gastrectomy Anaemia

Note - Higher incidence of anaemia in gastric ulcer group 37.03 per cent, duodenal ulcer group 22.5 per cent, and stomal ulcer group 25 per cent.

following histamine the difference was less marked 66.66 per cent in both groups of anaemic patients compared with 59.3 per cent in the non-anaemic. Hartfall using the histamine test meal concluded that the incidence of achlorhydria was similar in anaemic and non-anaemic patients following gastro-enterostomy and partial gastrectomy. We would stress that histamine is the strongest known stimulant of the gastric mucosa. The secretogogue value of any food taken by mouth is much less, and consequently patients who secrete free hydrochloric acid only when given histamine are unlikely to do so with ordinary food. We have found that achlorhydria in the non histamine test meal is more frequently associated with post gastrectomy anaemia than in those exhibiting free acid.

RELATION OF ANAEMIA TO SITE OF LESION

The highest incidence of anaemia in both the mild and severe groups occurred in patients who had been operated on for gastric ulcer - Table LVI. This finding was previously reported by Watson (1947) although he offered no explanation. There are probably two contributory factors. Firstly, the group of gastric ulcer patients in this series includes a much higher proportion of females than does the duodenal group - 28.57 per cent to 4.44 per cent. As we have seen females are much more prone to develop post gastrectomy anaemia than males. Secondly the incidence of post operative achlorhydria is much greater following resection

T A B L E LVII

RELATION OF POST-OPERATIVE HAEMOGLOBIN TO END RESULTS

RESULTS	HAEMOGLOBIN					
	LESS THAN 80%		80 - 100 %		MORE THAN 100%	
	NO.	PERCENT.	NO.	PERCENT.	NO.	PERCENT.
CURED 29	0	0·%	4	13·8%	25	86·2%
IMPROVED 20	2	10·%	3	15·%	15	75·%
I.S.Q. 7	0	0%	3	42·8%	4	57·2%
FAILURES 19	4	21·05%	5	26·31%	10	52·63%
SATISFACTORY	2	4·08%	7	14·28%	40	81·63%
UNSATISFACTORY	4	15·38%	8	30·76%	14	53·85%

Note - Increasing incidence of anaemia parallels progressively poorer results.

T A B L E LVIII

RELATION OF END RESULTS TO POST-OPERATIVE HAEMOGLOBIN.

HAEMOGLOBIN	END RESULT											
	CURED		IMPROVED		I. S. Q.		FAILURE		SATISFACTORY		UNSATISFACTORY	
	NO	PERCENT	NO	PERCENT	NO	PERCENT	NO	PERCENT	NO	PERCENT	NO	PERCENT
6 LESS THAN 80%	0	0	2	33·33%	0	0%	4	66·66%	2	33·33%	4	66·66%
15 80-100%	4	26·66%	3	20·00%	3	20·00%	5	33·33%	7	46·66%	8	53·33%
54 MORE THAN 100%	25	46·29%	15	27·77%	4	7·5%	10	18·52%	40	74·06%	14	26·00%

Classification of Patients on post-operative Grouping.

Note - Of the severely anaemic patients (Hb. less than 80 per cent) only 33·33 per cent were satisfactory compared with 74·06 per cent of those with Hb. of 100 per cent or more.

for gastric than for duodenal ulcer 92.5 per cent to 55 per cent in this series. Again as we have already seen the incidence of anaemia is greater in achlorhydric patients. These two factors explain the higher incidence of post gastrectomy anaemia in patients with a gastric ulcer.

RELATION OF ANAEMIA TO END RESULTS - TABLE LVII

Of the "cures" only 13.8 per cent of patients had a haemoglobin of less than 100 per cent. and in no case was it less than 80 per cent. Of the "failures" 47.36 per cent had a haemoglobin of less than 100 per cent - in 21.05 per cent it was less than 80 per cent.

The figures of the "in statu quo" and "improved" patients fell between these extremes. Using the classification of "satisfactory" and "unsatisfactory" results anaemia was present in 18.36 per cent of the former and 46.14 per cent of the later.

Classifying the patients according to their post-operative haemoglobin group (Table LVIII) only 33.33 per cent of the severely anaemic patients were satisfactory, compared with 46.66 per cent of the mildly anaemic and 74.06 per cent of those who were not anaemic. The figures indicate that poor post-operative results and anaemia are closely parallel. Watson, however, reported only two failures among thirteen anaemic patients.

RESPONSE TO TREATMENT

All six severely anaemic patients responded
/ well

well to ferrous sulphate, confirming the findings of Farris, Ransom and Collier (1943) and Jones (1940). Of the mildly anaemic patients the response was steady although less dramatic. In no case did we find an anaemia which was refractory and required liver as reported by Reker, Pack and Rhoads (1943) and Jones. These authors have reported cases which were resistant to therapy with iron and even some to liver and iron.

WHITE BLOOD COUNT

The white blood count for the series varied between 3,500 and 10,000 per cmm. with a mean of 7,200 per cmm. Still (1936) reported his highest finding in twenty-two patients with gastric resection for peptic ulcer to be 7,200 per cmm. and the average to be 5,040 per cmm. However, his white counts are based on patients with secondary anaemia. In the patients with a haemoglobin of less than 100 per cent the average W.B.C. was 5,800, thus confirming Still's findings.

C H A P T E R XXBLOOD CHEMISTRY

The following bio-chemical tests which were carried out were found to be within normal limits - CO₂ combining power, Blood Chlorides and non-protein nitrogen. Serum calcium, blood sugar and ascorbic acid have been discussed.

The plasma proteins except in six instances were above the level of 6 gms. per cent which was taken as the lower limit of normality. In no case was the albumin globulin ratio upset, and in none of the six patients with low plasma proteins (5 - 6 gms. per cent) was there evidence of liver disease as judged by the cephalin flocculation test and alkaline phosphatase estimation. There was no correlation between the plasma proteins and the end results.

S U M M A R Y

Seventy-five cases of partial gastrectomy for peptic ulceration have been reviewed. The site of the lesion was in twenty-seven instances gastric, forty duodenal, and eight stomal, and the sex relation sixty-four males to eleven females. The investigations have been essentially those of interest to the physician, but the results are of mutual interest to surgeon and physician alike.

The object of this review was twofold.

Firstly in order that we might investigate the cause of the lack of success which not infrequently follows this procedure. Secondly, in light of the recent adoption of vagal section in the therapy of peptic ulcer, it is necessary that we be au fait with the results of partial gastrectomy, the gauge by which the results of vagal section will be judged.

The method of selecting patients for investigation has been explained. As Hollander and Mage (1943) have pointed out the results of a series of patients admitted for follow up investigations can be applied to the patients not investigated but subjected to similar therapy for a similar complaint.

CLASSIFICATION OF RESULTS - A rigid classification of results was laid down. The three criteria of classification being the relief of ulcer symptoms, the post-operative working capacity and the presence or absence of new symptoms directly

/ attributable

attributable to the operation. Results were grouped into four categories - cured, improved, in statu quo, and failures. The cured and improved patients were labelled satisfactory and the in statu quo and failures unsatisfactory.

RESULTS IN GENERAL - Cured 38.66 per cent; improved 26.66 per cent i.e. 65.32 per cent satisfactory. In statu quo 10.66 per cent and failures 24 per cent, i.e. unsatisfactory 34.66 per cent. The percentage of satisfactory results is below the published figures of most authorities.

Following simple medical therapy such as the correction of anaemia, and dietetic therapy for post-prandial distension, there was an increase in the percentage of satisfactory results to 72 per cent. This illustrates the importance of an adequate follow up chiefly by a physician.

Throughout the whole series the results of partial gastrectomy were much less satisfactory in females than males. On admission the sex difference in satisfactory results was males 71.87 per cent, females 27.27 per cent. The poor results in women were greatly improved following simple medical therapy increasing the percentage of satisfactory results to 54.54 per cent.

RESULTS IN RELATION TO SITE OF LESION - On admission patients operated on for duodenal ulcer gave the highest percentage of satisfactory results 70 per cent. gastric ulcer 66.66 per cent, stomal ulcer 37.5 per cent. Most authorities

state results to be superior following resection for gastric ulcer. The poorer results in our series were we believe due to the large percentage of females in the gastric ulcer group - eight out of twenty-seven. The poorer results in females would therefore explain the less satisfactory results for that group.

Following simple medical therapy, however, the results were superior in the gastric ulcer group - 77.04 per cent satisfactory.

In general the results of partial gastrectomy tended to deteriorate with time.

INDICATIONS FOR PARTIAL GASTRECTOMY - Intractable pain was the commonest indication in this series. The results were best when the operation was performed for recurrent bleeding, 83.33 per cent satisfactory. Stomal ulcer gave the poorest results.

POST OPERATIVE PERIOD PRIOR TO RETURN TO WORK AND WORKING CAPACITY - Of the patients returning to work 75 per cent did so in the first six post operative months. In general early return to work and good results were parallel.

Fifty-four patients had a post operative working capacity of between 75 and 100 per cent, forty of whom were 100 per cent. Males recovered their working capacity more completely and more readily than did females.

POST OPERATIVE TEST MEALS - The special technique used has been described. Using the non histamine

test meal, achlorhydria was present in 92.5 per cent of patients with resection for gastric ulcer 55 per cent for duodenal ulcer and 75 per cent for stomal ulcer. Using the histamine test the incidence of achlorhydria was 85.55 per cent in the gastric ulcer group and 40 per cent in the duodenal ulcer group, the stomal group remaining unchanged at 75 per cent.

The most significant single finding in the test meals was free acid in the fasting juice. Such a finding was invariably accompanied by a high free acid in the test meal.

There was no significant difference in the results of the achlorhydric patients and those showing free acid. The presence rather than the absence of pepsin in the post-operative test meal was associated with favourable results.

POST-OPERATIVE GASTRIC EMPTYING TIME AND POST PRANDIAL DISTENSION - Almost invariably the period of gastric evacuation is markedly diminished by the operation of partial gastrectomy. Basing the results on the period of gastric evacuation we failed to note any correlation between a prolonged evacuation period and satisfactory results.

Thirty-eight patients suffered from post prandial distension in the first few post-operative months, and twenty mild symptoms after six months. The cause of the symptoms, we believe, is the small gastric remnant which had not yet distended sufficiently to cope with a full meal. We found

no support for the suggestion that post-operative hypoproteinaemia causing stomal obstruction was the basis of post prandial distension.

HYPOGLYCAEMIA AND THE DUMPING SYNDROME - Post prandial hypoglycaemia occurred in seventeen out of forty-five consecutive patients on whom a partial gastrectomy had been performed for peptic ulcer, and constituted the commonest complication of the operation in this series.

The symptoms produced were severe enough in five patients to preclude them from earning a livelihood.

It is suggested that rapid gastric evacuation is the basis of this hypoglycaemia, and that the "dumping" syndrome has identical clinical manifestations and an identical aetiology, so that the two conditions need not be distinguished.

The most effective method of treatment has proved to be a high-fat diet, six small meals a day instead of three large ones, and 1/2 gr. (32 mg.) of ephedrine before the three main meals.

Carbohydrate, fat, protein and vitamine absorption was normal. There were no cases of chronic post-gastrectomy diarrhoea.

POST OPERATIVE WEIGHT - Pre-operatively all patients were below their correct weight varying from -2 to -58 lbs. Following resection forty-five gained weight, the average being 11.6 lbs. while thirty lost weight, the average being 10.6 lbs. Failure to gain weight was more marked in

/ females

females.

There is a very close correlation between post-operative gain in weight and satisfactory results.

The details of three patients, fully investigated in relation to post-operative weight were given. We concluded that failure to gain weight in spite of an adequate calorific intake was due not to malabsorption but failure to utilise protein which was rapidly excreted in the urine. Testosterone had some effect in improving the nitrogen balance in one such case. The cause of this failure to utilise protein is problematical.

SERUM CALCIUM - Was normal in all but three patients, two males and one female. All had had previous perforations before the partial gastrectomy was performed - the woman three times and one man three times. The rarity of perforations in women has been remarked upon. There was no relationship between achlorhydria and the serum calcium. Is a low serum calcium a factor in causing a duodenal ulcer to perforate?

POST-OPERATIVE HAEMOPOIESIS - There was no evidence of macrocytic anaemia. Twenty patients suffered from microcytic hypochromic and normochromic anaemia, of whom six had a haemoglobin of less than 80 per cent. The incidence of anaemia was greater in females than in males, and in the gastric ulcer group than in the duodenal group.

The high proportion of females in the gastric ulcer group would therefore account for the higher incidence of anaemia. Based on the histamine test we found no correlation between achlorhydria and anaemia. Using the non-histamine test, however, there was a greater incidence of achlorhydria in the anaemic group.

A marked parallel existed between poor results and severe anaemia, and between the incidence of anaemia and the length of the post-operative period. All cases of anaemia responded to ferrous sulphate.

C O N C L U S I O N S

1. Some 65 per cent of patients subjected to partial gastrectomy for peptic ulceration are benefitted by the procedure.
 2. By a careful follow up of these patients the satisfactory results can be improved by 7 per cent.
 3. Females on the whole have a higher percentage of unsatisfactory results.
 4. Following partial gastrectomy patients find great difficulty in maintaining weight. This we believe to be due to failure to utilise nitrogen.
 5. Post prandial hypoglycaemia is the commonest post operative complication, and may be of sufficient severity to cripple the patient completely.
 6. Severe post-operative anaemia is rare. It is of the microcytic type and responds well to ferrous sulphate.
 7. There is little or no correlation between post-operative achlorhydria and the end results.
 8. The weight is the best single guide to the patient's post-operative condition.
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CHAPTER VI - CLASSIFICATION OF RESULTS

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