

A Radiological Study of the Stomach

after Gastro-Enterostomy.

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"A" - INTRODUCTION:

The first gastro-jejunostomy appears to have been performed either by Billroth at Nicolodoni's suggestion, or by Wölfer, both surgeons having done the operation in 1881.

Until the introduction of the opaque meal to common use about 1903 little was known as to the actual mode of function of the anastomosis, the idea being prevalent that the stoma remained open temporarily, or persisted only in the presence of pyloric stenosis. There is an enormous literature devoted to the surgical aspects of the operation, but very little published work has appeared on the radiological study of either the normal enterostomised stomach, or on the detection of lesions developing subsequently.

The first adequate röntgen study of this subject was made by Cannon. He confined himself to "normal" cases and his findings are discussed later.

(1)  
CARMAN and BALFOUR in 1915 appear to have been the first to write specifically on the opaque meal investigation of gastro-jejunal ulcer. They state that they could/

could find no previous references except the description of gastro-colic fistula by MATHIEU and SAVIGNAC.<sup>(2)</sup>

Following on this there appeared an article by J. T. CASE<sup>(3)</sup> which however adds nothing to the work previously done.

Indeed little or nothing new appeared on this subject for some years and in 1920 CARMAN<sup>(4)</sup> in his classic book adds nothing of importance to his 1915 statement. There appears indeed to have been widespread acceptance of the idea that the X-Ray demonstration of anastomotic lesions was, if not impossible, at least very improbable.

Following Cannon's early work, articles appeared on the normal working of successful gastro-enterostomies by OUTLAND, SKINNER and GLENDINNING and M. COHN.<sup>(5)</sup><sup>(6)</sup>

These authors attempted to establish the existence of some particular mechanism which could be taken as a normal, and any departure from this was therefore to be considered as indicative of a lesion, either organic, or in the form of perverted function.

The factors which render any such attempt fallacious are mentioned in the series of cases studied here.

Recently interest has again arisen in the radiological examination of both normal and pathological gastro-enterostomies, and the references to the current literature are given in relation to the context.

"B" TECHNIQUE -

Neither the fluorescent screen nor the film examination alone can ever be adequate for a thorough opaque meal examination; more especially is this the case in the examination of the post-operative stomach, where the detection of a lesion is usually more difficult than in the usual routine examination.

The greater part of the work on this subject described in the literature has been done after the administration of one of the usual types of opaque meal.

Carman used the "Haudek" method in which the meal is given six hours previous to the patient being seen by the examiner; the first examination is thus frequently done at a time when the transverse colon is filled with opaque material, and the greater curvature of the stomach obscured. This method, while undoubtedly saving time, is most undesirable in gastro-enterostomy cases, where the minute examination of the stoma is of primary importance.

The administration of an opaque meal during the first screen examination serves well to determine the general form, position and tone of the stomach. The degree of patency of the stoma and the relative amounts of food leaving by stoma and pylorus are also well seen. But by this means it is seldom possible to make an adequate examination of the form of the stoma/

stoma itself, or to reproduce on the negative any of the finer points elicited by palpation.

Any advance in the more accurate diagnosis of gastric lesions by radiological means, can only be looked for by the use of some method of delineating the actual configuration of the mucous membrane.

Various methods towards this end have been described, notably by FORRSELL,<sup>(7)</sup> RENDICH,<sup>(8)</sup> and BAASTRUP.<sup>(9)</sup>

Several writers, notably FORRSELL,<sup>(10)</sup> have suggested the use of some opaque medium which will adhere to the stomach wall, and indicated that, if a small quantity of such a substance be given and palpated widely over the stomach, it would be possible to reach a degree of accuracy of diagnosis impossible with "profile" opaque meal examination.

BAASTRUP<sup>(11)</sup> in his researches as to mode of stomach filling, which will be referred to later, confirmed the findings of Kaufman and Kienböck that any food ingested tends to pass inside food already present in the stomach. Thus by giving the patient half a teaspoonful of opaque mixture, followed by two hundred and fifty grams of ordinary rice meal porridge he was able to obtain pictures very roughly representing the gastric mucosa. Using this method, however, failures were very frequent and appeared unavoidable.

Laurell, having succeeded in obtaining very fine pictures/

pictures of the colon walls by giving a small enema, and inflating the colon when this had partially dried, indicated that a similar technique could be applied to the stomach. On attempting this by inflating the stomach, after a small quantity of sticky opaque food had been ingested, I found, however, that, as soon as the stomach walls separated, all the barium settled in the lowest point of the greater curvature. This method does not seem likely to be successful, as there is no fluid absorption in the stomach comparable to that in the colon.

After experiment it was found that by giving the patient one tablespoonful of a mixture such as :-

Mucilage of Acacia .....	1500	grams.
Barium Sulphate .....	180	"
Water .....	210	"

it was possible in many cases to massage this over the stomach wall while the patient was recumbent. Prints from films taken in this way are shown. It was found impossible to use this method in stomachs which were either abnormally high or low, palpation being interfered with by the costal margin and pubis. Again it was found that no form of opaque mixture would adhere to the stomach wall if there was any food already present in the stomach, or even if there was any more than a minimum of gastric secretion present. It may be mentioned here that it was found very much more/

more simple to get the barium mixture to adhere to the walls of the stomach in which a gastro-enterostomy has been performed than in the normal case; this being due to the almost entire absence of the secretion normally found in the fasting stomach. It is true that films may be obtained showing a fine network of opaque material on the stomach wall by the use of carefully graduated pressure with pads of gauze or cotton wool, but this method is quite unreliable and abnormal appearances, due to the pressure, have always to be discounted.

The accuracy with which the form of the mucous membrane may be depicted by a small amount of syrupy opaque material has frequently been shown at operation.

(12)

H. HELLMER, using a modified Rendich method to study the mucosa around gastro-enterostomy openings, was able to verify his findings in five cases by post-mortem examinations.

"Serial Radiography", by which is meant the taking of several films in fairly rapid succession, so strongly advocated by L. G. COLE,<sup>(13)</sup> has its uses principally in the demonstration of defects in the normal action of the stomach. It has here been used to demonstrate on the films the various modes of function which stomas/

stomas may show at the screen examination, and also to demonstrate the variations rapidly taking place in the form of the small intestine. For this purpose a serial machine designed by Beclere has been used. With this it is possible, while screening, to move a film into position and make the exposure within a fraction of a second of having seen the phase which it is desired to photograph. This method serves well also to show the constant presence of any abnormal feature which may be seen at the fluorescent screen examination.

Examination in both upright and recumbent positions should always be done. But in cases following gastro-enterostomy, the upright is the more generally useful. <sup>(14)</sup> L. ARISZ appears to favour the lateral recumbent position but little, if anything, seems to be gained by this rather awkward mode of examination. The technique followed in the examination of the later cases in the series here described was as follows:-

The patient, while sitting on the screening couch, was given one dessert-spoonful of the adhesive mixture previously mentioned. Immediately after swallowing this, the patient was screened in the recumbent position. As serial films with the Beclere apparatus could only be made upright, the patient was/

was next put in the screening stand and these films taken. Following on this the patient swallowed about half a cupful of a thin suspension of barium in water. The entry of this into the stomach was watched and was found more useful than the standard opaque meal in estimating the relative patency of the stoma and pylorus.

The standard opaque meal was then given consisting of:-

Barium Sulphate .....	200 grams.
Grated Fresh Bread .....	65 "
Milk .....	10 ozs.

Half the milk is used to boil the bread and this is then stirred to a fine paste with the barium and remaining milk, which have been previously mixed.

Such a meal is necessary if any true idea is to be obtained of the gastric motility, and any information gained by a residue occurring in an ulcer crater.

The patient was again screened after an interval of six hours and a film taken. The stomach might be refilled to confirm the presence of any abnormality seen at the first examination or to locate accurately a residual flake of opaque material.

A film of the entire abdomen was taken after twenty four hours but no screen examination was done.

Examination in lateral and oblique positions should always be done, but has seldom been found to give much additional information in these cases.

Palpation, always using a suitably gloved hand, is of/

of primary importance, while screening. Here may be  
mentioned the useful tip given by A. E. BARCLAY (15)  
not to have the patient "standing to attention" but  
rather "louging" in the screening stand with the feet  
placed well forward; this helps greatly in getting  
good relaxation of the abdominal wall.

By fairly heavy palpation the first mouthful of the  
meal may be spread over the stomach walls and a  
rough idea obtained of the form of the mucosa.

The site of a stoma may also be determined in this  
way in a case in which no opaque food is leaving by  
it. Palpation is also of use in obtaining an idea  
of the degree of stenosis or spasm present at the  
pylorus, and in outlining the duodenal cap. It is  
also possible, by pressure with the tip of one finger  
to correlate very accurately the position of a tender  
spot with the underlying organ.

The exposure of the double-screened films were made  
using 30 milliamperes, 100 kilovolts and one third  
of a second time. The time of exposure was varied  
slightly to suit the stature of the patient and no  
Potter-Bucky diaphragm was used except for the twenty  
four hour film. The tube distance was about thirty  
inches.

"C" NORMAL GASTRO-ENTEROSTOMIES -

On examining the stomachs of patients who have been entirely symptom free after gastro-enterostomy a wide variation in the mode of action of these stomachs is found. It is this very variation which creates the difficulty in deciding what can be regarded as abnormal in patients who give clinical evidence of some disordered function.

The stomach is almost invariably situated fairly high in the abdomen. This is found even in those cases where, before operation, there has been considerable dilatation of the stomach. That this contraction can occur in a short time is well shown in Case No. 1, where examination showed a prepyloric tumour causing stenosis and marked dilatation. Gastro-enterostomy was done preliminary to resection of the growth. Six weeks later X-Ray examination showed very great diminution in the size of the stomach. It is this high position which frequently renders palpation and any estimation of the mobility of the stomach so difficult in these cases.

The normal movements of the human stomach are now well recognised. In the "J" or "Fish-Hook" type of stomach, peristaltic waves are seen to commence high up on both curvatures, and to become deeper as they pass/

pass downwards. The waves on the lesser curvature stop in the region of the incisura angularis and those on the greater curvature at a corresponding point. As each wave takes approximately twenty seconds to traverse its full course two or three waves may be seen at one time. These waves carry the food into the pyloric antrum which shows no peristalsis but a rhythmical concentric contraction which occurs about every minute, this contraction in the healthy stomach being always accompanied by a relaxation of the pyloric sphincter. Thus at an interval equal in time to about three peristaltic waves there is a discharge of food into the duodenum. In the gastro-enterostomised stomach many variations are seen in the mode of emptying but in the vast majority of "normal" cases, the above movements can be seen to occur quite uninterrupted by the gastro-enterostomy opening, and irrespective of the amount of food which may be passing through it. It is certainly quite definite that the peristaltic waves pass over the stoma, and that their passage bears no relationship to the exit of food through the stoma. The amount of food actually leaving the stomach at each antral contraction depends of course on the degree of pyloric patency. In the event of spasm or stenosis of the pylorus there is a very large reflux of the antral/

antral content into the fundus, this probably constituting the so-called gastric reverse peristalsis. While the movements of the stomach are as described, the actual course of the gastric contents shows enormous variations.

There are two very important points in connection with opaque meal examinations which may be pointed out here. The first is the extreme difficulty of making any quantitative estimation of stomach or bowel content from the shadow of an opaque meal. It is lack of appreciation of this point that has lead to a very great number of fallacies in diagnosis and experimental work. The difficulty arises from the very small amount of barium which is required to make a mass of stomach or bowel content completely opaque to all radiation. Perhaps this is forcibly shown most frequently when, at the examination of a stomach after six hours, a residue is found apparently equal to the mass seen immediately after the ingestion of the meal; but at the same time the ileum and proximal colon may also appear to contain the equivalent of the entire meal. Similarly a very small amount of residual barium only is required to mix with bowel content and give the appearance of intestinal stasis when in reality the major part of the meal/

meal has been evacuated in normal time. This appearance of absolute opacity occurs more frequently on films when a Potter-Bucky Diaphragm is used and thus tends to cut out the finer degrees of trans-radiancy which are the only means of arriving at a true estimate of the actual barium content creating the shadow.

Realisation of this is needed to appreciate the limits of accuracy which are possible in estimating the degree of stasis in the stomach after the usual opaque meal.

The second point in connection with the relative density of barium is one which once appreciated explains some of the phenomena seen on the fluorescent screen. It is possible to have a stream of barium so fine that its absolute density is no greater than that of the body tissues, so that it is quite invisible on the screen. Thus it is that barium can frequently be seen to appear in the second part of the duodenum where none has been seen to pass through the pyloric canal even when this is very carefully watched.

These two features of opaque meal examination are here offered as at least partial explanations of inaccuracies in diagnosis, and as pertinent in showing how difficult it may be to estimate the degree of patency of either the pylorus or the gastro-enterostomy opening/

opening and still more to obtain an accurate idea of the relative amounts of food leaving by them.

Carman and many others have stated that a stoma through which there does not appear to be a sufficiently copious flow of food is probably stenosed by a gastro-jejunal ulcer, and that this is a sign of great diagnostic import, always assuming that the stoma is known to have been originally of adequate size.

yet it is only a matter of examining a sufficient number of "normal" cases to realise that a narrow, but rapidly moving, stream of barium frequently occurs through a well formed stoma, and that there need be no increase in the emptying time of such a stomach, over that seen in one from which a wide stream of barium is leaving.

very frequently, indeed, the distal coils of the jejunum may be seen to fill out although there has been no visible passage of food from the stomach.

The normal mode of filling as seen in the healthy, unoperated stomach and the movements of the gastric contents is of great interest in itself and in its bearing on the mode of gastric function, after gastro-enterostomy. Only the "J" or "Fish-Hook" form of stomach will be dealt with as these constitute fully ninety per cent of human stomachs.

The/

The first small amount of opaque material swallowed is held up at the cardia for a varying period of time, forming a triangular shadow the base of which is adjacent to the air cap of the stomach. After a short time, or on more food being taken, the opaque food is seen to descend in a thin stream along the lesser curvature. It is the subsequent course of the food which has given rise to much discussion. There is, however, unanimous agreement that food of fairly solid or semi-solid consistence pursues a vertical course leaving the lesser curvature as soon as it tends to become horizontal and descending to the lowest point on the greater curvature.

Controversy arises as to the existence of a tubular canal which, it is maintained, acts as a direct passage for fluids to the pyloric antrum without mixing with the more solid gastric content. This channel constitutes the "Magenstrasse" of Waldeyer.

(16)

C. I. BAASTRUP in an elaborate article on this subject reviews a very wide literature and contributes some experiments of his own. He comments:-

"That a clean groove, free from any  
"other contents of food and thus adapted  
"for fluids alone, may be formed in an  
"otherwise filled stomach, seems to me  
"quite incomprehensible."

With this one would be inclined to agree. The theory/

theory that such a course for fluids might occur seems to have been derived from the undoubted occurrence of such a "magenstrasse" in dogs, and certain monkeys, and the idea of such an action in man was advanced long before the advent of radiology.

(17)

(RETZIUS 1862. Reference from Baastrup.)

It is, of course, a well established fact that there is a clearly defined band of muscle fibres running down obliquely on the anterior and posterior stomach wall continuous above with the deep oesophageal muscle and below with the circular coat of the pyloric antrum. But dispute arises as to the existence over these oblique fibres of a special mucosal formation which would be capable of forming a canal such as that described. (Fig. 2.)

It is remarkable that there should be any dubiety in this matter after the established usage of the opaque meal. Yet we find GROEDEL (18) citing experiments which he has made confirming such a flow of fluids in the human stomach, and Forrsell stating that he does not consider there is any evidence for such a "magenstrasse" action. The application of this to the gastro-enterostomised stomach is that, in Groedel's view, there would be an escape of fluids by the pylorus, while the anastomosis would be dealing with a very much more solid gastric content than might otherwise/

otherwise be expected.

In the early human embryo the cardiac portion of the stomach is seen to have developed as an outgrowth from the rest of the alimentary tract, and it is not until the third or fourth month that it has the formation found in the adult stomach.

In one of the Indian monkeys, *Semnopithecus*, this developmental form persists throughout life. The "cardia" forms a large sac in which the more solid food remains to be digested while the fluid ingested passes on along the "lesser curvature", just such a mode of digestion as has been suggested as occurring in the human.

Photographs are shown of a *Semnopithecus* stomach opened along the greater curvature, demonstrating the essential similarity of the mucosal formation with that of the human stomach which is given for comparison.

(Fig. 3 and 4.)

While in a very few cases I have seen fluid reach the pylorus by passing along the lesser curvature, if swallowed when the stomach is quite empty, there can be no doubt that in the vast majority of stomachs the barium "drink" leaves the lesser curvature as soon as it begins to turn horizontally to form the *incisura angularis*. If solid food has been taken immediately previously there is a noticeable tendency for/

for the liquid ingested to form a layer above this for a short time, but the peristalsis and antral contractions are sufficient to ensure that the food leaving the stomach is a fairly homogeneous mixture. As the first small quantity of food descends from the cardia in the filling of the normal gastro-enterostomised stomach, it is an invariable finding that some escapes through the stoma. This flow may continue or may temporarily cease but is of great interest as indicating a patulous condition of the stoma in the fasting stomach.

In the healthy stomach (without operation) it is frequently noticed that the head of the entering meal undergoes a slight degree of dilution by fluid already present in the fasting stomach. This dilution may be seen to a much greater extent in cases of pyloric spasm or stenosis, so much so as to constitute a sign of diagnostic value. It must be noted that this fluid is gastric secretion which has failed to pass on to a normal extent and not retained food, as it is well seen in cases where all possibility of retained food has been excluded.

No such dilution of the head of the entering stream of barium is ever seen in the gastro-enterostomised stomach when the stoma is working satisfactorily. This is mentioned at this point, merely because it is, to/

to a slight extent, confirmatory evidence of a patency of the pylorus in the fasting stomach. This excess of fluid found in obstructed stomachs may be either a normal amount of gastric secretion which has failed to pass the pylorus, or may be true excess of gastric secretion. In the latter case it might be expected that it would be found frequently in enterostomised stomachs as the lesions requiring such an operation are so frequently associated with a hyperchloridria.

All the examinations were done in the morning, and therefore after a period when the patient was recumbent, in which position there would be a tendency for the gastric secretion to leave by the stoma, even were this not at the most dependent point of the greater curvature. After some time in the upright position there is almost certainly the same tendency for the retention of gastric secretion as is found with barium in those cases where the anastomosis is high on the posterior wall.

In the majority of cases the flow through the stoma is not continuous but temporarily ceases after the first small amount of food has escaped. The stomach then fills in the normal manner and a meal of the usual three hundred grams bulk is commonly sufficient to fill it to a level well above that at which the stoma/

stoma is placed.

It is the subsequent mechanism of evacuation which shows the greatest variations. In a certain number of cases a copious stream of barium commences to flow from the stoma from the moment when the stomach starts to fill, and continues until it is empty.

This only occurs in cases where the stoma is placed at the lowest point of the greater curvature, otherwise the stream only continues until the gastric content has reached the level of the opening. These cases with this extremely rapid evacuation frequently give very satisfactory histories of post-operative improvement, and do not appear to suffer in any way from the lack of true gastric digestion. This would appear to corroborate and extend the statement of MacLean in discussing the intensive alkaline treatment of gastric ulcers that:-

"Stomach digestion is not essential to health and its temporary suspension will do no harm." (19).

More commonly however it is found that, after the first small amount of barium has left by the stoma in the process of filling, there is a quiescent period in which very little evidence can be seen of any gastric activity and during which no food leaves the stomach. Following this, peristaltic waves are seen to start and proceed down both curvatures, the pyloric antrum forms and delivers a variable amount of food/

food into the duodenum. About the same time the stoma begins to show rhythmical activity allowing the escape of small quantities of food into the efferent jejunal loop. The periodicity of these relaxations of the opening shows a wide variation in different cases, but is fairly constant in any one patient; it is certainly not synchronous with the pyloric activity, and not dependent on the passage of peristaltic waves. This rhythmical exit of the food through the anastomosis was early observed by X-Ray workers. Cannon and Blake reported regular duodenal contractions after operations of the Finney type. Kocher had previously stated that the stoma after gastro-jejunostomy underwent regular contractions, and really developed a sphincteric action. J. T. CASE (20) having also observed the periodic manner in which the food passed down the efferent loop did not think that there was actually any activity of the stoma but reported regular concentric contractions of the efferent jejunum about three centimetres distal to the anastomosis; these he thought always occurred at the same site and indicated the post-operative development of a sphincter which served to regulate the rate of stomach emptying.

As against the likelihood of any such sphincter action either at the anastomosis or in the jejunum, it must/

must be pointed out that there is no appreciable difference in the mode of action of the anastomosis whether the case be examined very soon after operation, or after the lapse of years. It is reasonable to suppose that such an action as above described would take some time to develop,

Again it is impossible to imagine the formation after operation of a nerve mechanism in the stomach such as <sup>(21)</sup> KEITH describes as holding for the normal sphincters of the alimentary tract.

It is here suggested that the periodical passage of food through the anastomosis is the result of the normal tonic activity of the stomach.

The muscular structure of the gastric wall is, like that of the voluntary muscular system, kept in a state of continuous fine contraction and only by virtue of this is it able to perform its normal movements. The existence of this tonic control is shown by the ability of the stomach to support a column of food several inches high. This power indeed is used for X-Ray purposes as an index of the degree of gastric tone present.

It will readily be seen that there will be a much greater tendency for the edges of the anastomosis to be held in close apposition in a tonic or hypertonic stomach; and that this will be the case whether the stoma be longitudinal or vertical owing to the longitudinal/

longitudinal and circular formation of the gastric musculature.

That the tonic condition of muscle is constantly undergoing fluctuations has been frequently demonstrated physiologically, and this would, on theoretical grounds, adequately explain the anastomotic "sphincter" action. That this is what actually occurs is indicated by several radiological findings. In the stomach which has become atonic and dilated before operation, and remains so, it is nearly always found that there is rapid emptying by a continuous stream of barium; and that an interrupted exit of food only occurs in stomachs which show persistence of tone.

Again one of the most constant signs of early pyloric obstruction found at X-Ray examination, is a sudden failure of tone in a stomach which has supported the weight of the ingested barium well for some time.

Thus in a majority of cases of duodenal ulcer causing stenosis or pyloric spasm the stomach is of excellent tone at the first examination, but if refilled after four hours the barium lies as an inert mass in a stomach now devoid of tone and peristalsis. This observation is here pertinent because it is frequently found in the enterostomised stomach that at the first/

first examination food will only leave the stomach very spasmodically or not at all, but on re-examination later a copious stream of barium pours through the anastomosis; this fitting in well with the theory that the gastric tonicity has a marked control over the patency of the stoma.

One perfectly constant feature is that food leaves by the stoma only as long as the level of the gastric content is higher than that of the stoma, this being most noticeable when examination is done with the patient upright. If, after the passage of food by the stoma has ceased in this position, the patient is examined recumbent, the barium may again be seen to leave by this route. Thus there does not appear to be any reason to regard gastro-enterostomy as any other than a purely drainage operation; the rate of drainage by no means necessarily depending on the size of the anastomotic opening.

While as has been said there is every reason to suppose that the normal control over the stoma is exercised by the gastric tone, this does not exclude the possibility of a spastic closure of the anastomosis under irritative conditions. That spasm may occur is frequently taken for granted in the surgical literature. There is, however, very strong radiological evidence of its existence to be found on the fluorescent/

fluorescent screen examination. If, while food is seen to be leaving regularly, heavy palpation is done over a tender spot, it is not uncommon to find that there is immediately a cessation of the passage of food through the anastomosis; just such an appearance is seen due to pyloric spasm on pressing over a "niche".

(22)

H. HELLMER in his careful correlation of radiological and anatomical findings after gastro-enterostomy concluded that formation of the muscularis mucosae around the stoma was such as to render the existence of spasm very probable. (Figs. 7 and 8.)

It may be of some interest here to insert an abstract from "Lenk's Index to X-Ray Therapy" compiled from the work of Holzknecht in Vienna.

"When the bad functioning of the anastomosis is not due to anatomical causes such as high position or adhesions but upon spasm at the site of the anastomosis excellent results can be obtained". (by X-Ray therapy.)

The action is attributed to the inhibition of the spasm by the radiation action on the nerve ends.

The mode of action of the pylorus in gastro-enterostomised stomachs is that seen in the unoperated case, the amount of food leaving at each antral contraction depending on the degree of patency and period of relaxation.

This/

This is complicated by the frequency with which there is a duodenal deformity resulting from the lesion for which the operation was performed. As a rule, even when there is no stenosis less food passes into the duodenum at any one antral contraction.

If the actual form of the anastomosis is now considered as distinct from its mode of action we find

FORSELL writing in 1924:-

"We do not yet know sufficiently in detail  
"the normal Roentgen picture of the gastro-  
"enterostomy and of the jejunal loop close  
"to it." (23).

(24)

Immediately after this H. HELLMER published an article "Etude sur la muqueuse gastro-intestinale "apres gastro-enteroanastomose". In this article are shown illustrations obtained by the use of Rendich's technique of gum arabic and barium. These are very similar indeed to those which have been obtained in the examination of this series of cases. Hellmer's article is an attempt to prove the existence of movements of the mucous membrane independent of that of the main muscular coat of the intestine. He makes much of the fact that the width of the stream of barium leaving by the stoma is not constant. That this is entirely fallacious is obvious when it is realised that, while an anastomosis is from two to three inches in diameter, the stream of barium is seldom/

seldom more than half an inch wide as it issues from the stomach, and is therefore no index as to the actual size of the opening. It has already been pointed out that the rate of passage of food through the stoma is in all probability controlled by the gastric tone.

I have been able to examine the stomachs of six patients who have died at varying intervals after the performance of a gastro-enterostomy.

Before opening these post-mortem stomachs a small quantity of the same opaque material as was used in the living subject was introduced. If the barium mixture was allowed to take its own course through the stomach which was held upright, it was found that on X-Raying the specimen a very rough picture of the coarser rugae along the greater curvature was obtained. Without manipulation no barium passed through the stoma. If, however, the stomach walls were even slightly massaged together and some barium expressed through the stoma, films could be taken which reproduced very closely the formation of the mucosa as seen on opening the specimen. If any more than a tablespoonful of the mixture was introduced it was found impossible to show any structure finer than the three or four high rugous folds running down nearer to, and parallel with, the greater curvature. The smaller/

smaller quantity of opaque material with light massage demonstrated the fine maculated structure.

(Fig. 9).

It should be noted that the films are produced not, as has been supposed, by the barium adhering to the ridges of the mucosa but by lying in the interstices between them. The duodenal and jejunal loops give the appearance as produced by the routine X-Ray technique, the valvulae conniventes being clearly shown by the barium lying in their deep interstices.

In contrast with these appearances it will be seen that in the films taken of patients, the barium lying on the stomach wall has a reticulated formation corresponding neither to the coarse or fine structure as seen in the post-mortem specimen. (Case Nos. 10 and 11.) The photographs, both clinical and X-Ray serve to show that there is a ridge of fibrous tissue, about one eighth of an inch high and about the same breadth dividing the gastric from the jejunal mucosa. (Case No. 12.) No evidence of this can be made out in the radiograms of the unopened specimen, or in any of the serial films taken of patients.

It is interesting to note that, in the specimen taken nine weeks after operation, there was a marked smoothing out of the gastric mucosa distal to the anastomosis, and a distinct tendency for the rugae to turn/

turn downwards towards the stoma. In this case there was no suspicion of any gastr~~ic~~-jejunal ulcer, the patient having died from an intercurrent infection, the anastomosis apparently functioning well. (Case No. 12).

Hellmer also found this tendency for a convergence of the rugae on the stoma, and this raises the very important question as to what is the actual mode of healing at the line of suture, because it has long been recognised that a "puckering" of the gastric rugae forming the so-called "corona radiata" is strong evidence of the presence of an ulcer.

In 1906 GOULD and HARRINGTON (25) found that whatever the mode of suture, there was sloughing of the mucosa round the margin of the anastomosis.

H. J. PATERSON (26) writes -

"If this be true then it follows that every "gastro-jejunostomy is followed by a gastro-jejunal ulcer."

He however continues to state his belief that primary union does occur in the human.

D. P. D. WILKIE (27) from experimental work concluded that union takes place by granulation and is complete on the average in seven days.

MOYNIHAN (28) states that union by first intention does not occur at the site of the anastomosis.

in none of the cases examined at post-mortem was there/

there any evidence of primary healing to be made out. In Case No. 13 the clinical photograph shows the sutures quite intact after seven days, there being only a slight degree of union by early granulation tissue. It would thus appear that the actual line of the anastomosis consists of scar tissue, which explains the convergence of the mucosal folds on the stoma and at the same time invalidates any X-Ray findings which might be considered as pointing to a healed gastro-jejunal ulcer.

By the preceding description of the function and form of the normal anastomosis, an attempt has been made to show that no conclusions can be justifiably formed regarding anastomotic lesions by any other than direct evidence, e.g. a true "niche" sign in the case of gastro-jejunal ulcer. This is in accordance with the opinion of H. Hellmer (Personal communication). The opaque meal on leaving by the stoma is immediately seen in the jejunum, readily recognised by its fine feathery appearance. It is quite impossible to tell whether the barium has entered the afferent or efferent loops otherwise than by carefully following its subsequent course.

The human small intestine is found at post-mortem to have an average length of some twenty feet and a diameter/

diameter of about two inches at the proximal and about one inch at the distal end. From formalin hardened bodies it has been decided that the approximate length during life is nearer fifteen feet and the diameter from one to half an inch. Of this, excluding the duodenum, the proximal two-fifths are taken as representing jejunum and the distal three fifths ileum. From observations by X-Rays it would appear that, while any exact measurement is impossible, the length is even less than that found in the hardened specimens. In those cases of gastro-enterostomy where there is a copious flow of food through the stoma the jejunum is seen to be very much wider than normally, the valvulae conniventes are distinctly seen and no peristaltic activity is visible. This condition would seem to be due rather to a loss of the normal tonicity than to true dilatation, as the diameter does not exceed the two inches found post-mortem. It would appear to be important to realise that this condition may occur as one of the physiological results of gastro-enterostomy, because such a "dilated" appearance is rightly considered pathognomonic of some small intestine obstruction, in unoperated cases. When, however, as is more usual, the gastro-enterostomy opening only allows of the occasional passage of small amounts of food the jejunum maintains its normal diameter of about three quarters/

quarters of an inch. In such a case the passage of the barium is relatively slow, taking from five to ten minutes to traverse the jejunum and proximal ileum. When a constantly patent stoma and wide proximal jejunum is present the head of the meal can be observed to flow with great rapidity and reach the pelvic ileum in some ten to twenty seconds.

In several cases a small "pool" of barium has been observed to form in the jejunum at a distance (on the film) of about two inches from the stoma. This at first was thought to be pathological but has been seen too frequently where no derangement of the stoma function was suspected. It is considered as being probably due to a pouch formation in the jejunum between the anastomosis and the opening in the transverse meso-colon. The opaque food lies in this "pouch" after all the adjacent bowel is empty and finally empties itself by one or two very vigorous peristaltic movements almost amounting to tonic contractions. (Case No. 15.)

Reference has already been made to the frequency with which the first part of the duodenum shows some deformity from healed lesions. The second and third parts of the duodenum commonly appear rather more narrow than is found in the normal stomach, but this is probably due rather to the smaller amount of opaque food/

food passing through them than to any genuine narrowing of the bowel lumen.

"D" - Findings in cases which have developed gastric symptoms subsequent to gastro-enterostomy.

Many of the signs of perverted function found in the pathological gastro-enterostomised stomach are so much those that would be logically expected that they will only have to be briefly mentioned.

Thus it is only natural when a stenosis of the stoma has occurred and there is no free exit by the pylorus that there will be an atonicity and dilatation of the stomach. In such a case the entering stream of opaque food is not delayed at the cardia but drops rapidly to the lowest point of the greater curvature. While a small amount of narrowing of the stomach at the site of the stoma may occur in normal cases, any marked degree of hour-glass deformity is definitely abnormal.

It has been pointed out that the healthy gastro-enterostomised stomach is usually small, high and of good tone, yet it cannot be considered definitely indicative of some post-operative lesion if it is found as low, atonic and dilated as before operation.

This apparently will occur where adequate drainage has been provided to maintain comfort yet insufficient to stimulate the stomach to contraction or where pre-operative dilatation has gone so far that the muscle fibres have lost all chance of recovering their tone. In some of these cases there is a very large residue present/

present at the six hours examination but this does not appear to be incompatible with an excellent post-operative history. In such cases it would appear as if the operation had failed in what is perhaps its main feature -- adequate drainage. The freedom from further trouble in these cases may depend on the extent to which the cause of the original condition has been dealt with, in the way of removal of infected teeth, diseased appendix or pathological gall bladder. But it may be again pointed out that this stasis only occurs as long as the patient remains upright and that there is almost complete emptying of the stomach in the recumbent position, no matter where the stoma be placed in the posterior wall, so that, at the worst, there is little likelihood of more than a twelve hour gastric residue, or of any accumulation of hyper-acid fasting juice.

These dilated stomachs usually show little or no peristaltic activity and the opaque food is found after six hours to be lying as a stagnant mass with its upper level a little below the site of the stoma. There is little tendency for the food to leave by the pylorus owing to the lack of peristaltic activity always a concomitant of dilatation.

The wide range of stoma activities to be regarded as coming within the "normal" have been described, and it/

it will be seen that little short of complete failure of any food to pass through the stoma can be considered as definitely pathological.

It is remarkable that in the cases examined this complete occlusion of the anastomosis was only found twice. The first of these was found at operation to be due to a "kinking" of the afferent and efferent loops by the transverse meso-colon, no true closure of the stoma having taken place. (Case No. 16.)

The second case was one in which the anastomosis to the distal sac of an hour-glass stomach appeared to be completely obstructed, this finding being confirmed at post-mortem examination. (Case No. 17.)

The detection of lesions in the stomach after gastroenterostomy is to be looked for in variations from the normal form rather than in perversion of function. For any belief whatever in the accuracy of stomach examination by the opaque meal it is necessary to appreciate the value of the "niche" sign. This consists in the filling of an ulcer crater by the opaque material, causing a small projection to be seen from the stomach wall at the site of the ulcer. The first description of such a sign is credited by Carman to Reiche in 1909 and the name was given by Haudek in 1910. It is now universally recognised that a well/

well defined "niche" is the only diagnostic sign of ulcer to be shown by X-Ray examination. There are, of course, numerous "indirect" signs which may singly or collectively form exceedingly strong presumptive evidence of ulcer. In the diagnosis of gastric ulcer the indirect signs of greatest value are spasm, sharply localised tenderness and a convergence of the folds of mucous membrane to one point, resulting from the scarring produced by a chronic ulcer. If all these occur at one site, even in the absence of a niche, the diagnosis of ulcer may be made with considerable confidence.

Opaque meal examination has been brought into some disrepute by the attachment of too much importance to any one of these indirect signs alone. It is of the utmost importance to appreciate that, as the niche sign can only occur with penetrating or "chronic" ulcers, the diagnosis of "acute" ulcers must necessarily depend on these indirect signs. In fact it may be said that the majority of acute ulcers will give no X-Ray evidence of their presence. It is very much a matter of luck whether the examination is done at a time when there is a spastic deformity to indicate the site of the "mucosal erosion".

Apart from spasm the most useful symptom is tenderness, sharply and persistently localised to some area of the/

the gastric wall, more especially if this coincides with a site of election for gastric ulcer. It may be doubted whether superficial tenderness is any indication of a lesion lying precisely under the tender spot, but it is found so frequently that just such a "sore" area overlies a well defined, indisputable ulcer crater that there can be no reason for doubting its suggestive value in cases where no niche is visible. Moreover when, at the initial screen examination, no obvious lesion is seen, a general palpation will frequently elicit one area of abnormal tenderness, at which, on closer inspection, may be found a small niche; and just such a niche will again and again be found at operation to have represented accurately an ulcer. These tender spots are familiar to all clinicians, but an appreciation of their relationship to the underlying lesion is really only possible by the opaque meal as, at operation there is such an upsetting of all normal apposition that this is rendered impossible.

Even SIR J. MACKENZIE in describing his theory of referred pain writes:-

"The pain in the epigastrium was so severe  
 "and limited to so small an area that he  
 "felt certain if he pushed a long needle  
 "through it he could penetrate the ulcer." (29)

At the screen examination it is very noticeable that,  
 palpating/

palpating with the tip of one finger for the sake of accuracy, the amount of pressure required to elicit this localised tenderness is largely dependent on the laxity of the abdominal wall.

Although perhaps not entirely pertinent here, it may be mentioned that the pressure required is just such as might be thought to be needed to press the inflamed visceral and sensitive parietal peritoneum into close apposition and is very suggestive of the truth of MORLEY'S theory. Indeed MORLEY himself writes:-

(30)  
 "My conclusion is that when the radiologist  
 "elicits a tender spot on pressure over the  
 "ulcer he is pressing the sensitive parietal  
 "peritoneum into a position in which it re-  
 "ceives some degree of irritation from con-  
 "tact with the ulcerated area." (31)

The importance of these findings is of particular importance in the examination of the duodenum in the gastro-enterostomised stomach. Here there is less likelihood of finding a confirmatory spasm opposite a shallow ulcer; and in any case there is so frequently a definite deformity due to the pre-operative lesion that localised tenderness is almost the only remaining evidence of recurrent duodenal ulcer, for it must also be remembered that, owing to the presence of the stoma, no importance can be attached to the degree of gastric motility.

One instance may be mentioned in which no other abnormality/

abnormality was found at the X-Ray examination than just such a "sore spot" over the duodenum as above described. The patient came to operation on clinical findings and in the duodenum there was an old ulcer scar with no evidence whatever of an acute condition; nor in this case was there any pyloric stenosis.

It may also be worth mentioning that, in examining post-operative cases, tenderness will frequently be elicited due to the abdominal scar which may, at the screen examination, falsely suggest some underlying lesion.

That the alimentary mucous membrane might be capable of movement independent of the recognised intestinal action was first suggested by Forrsell in 1923. He arrived at this conclusion by a careful study of the mucous membrane structure as seen by opaque meal examination, and directly as at colostomy and other fistulous openings. Forrsell credited this movement to the action of the muscularis mucosae, and his work has received very wide acceptance.

(32)  
Lately L. G. COLE in a very detailed study of the gastric movements comes to the conclusion that the entire gastric peristalsis is carried out by the muscularis mucosae and that the function of the "regular" muscular coats is purely that of maintenance of tone. Certainly/

Certainly in the cases in which sufficiently good serial films were obtained of the mucosa around the stomas I have been quite unable to trace any constancy in the configuration of the folds.

The practical application of these findings to pathological conditions is of very great importance. It has long been recognised that there is a discrepancy between the depth of an ulcer as shown on the X-Ray film and the degree of penetration as found at operation. An entirely false impression of depth may be given to an ulcer which has actually penetrated no more than the mucous membrane, by the oedematous, hyperaemic and indurative changes which may be present in the mucous membrane at the edges of the ulcer. Thus a shallow ulcer may produce a "niche" sign in which the crater appears to be actually greater in depth than the thickness of the gastric wall. (Fig. 18). This, while of interest, has little importance other than casting some doubt upon the ability of the radiologist to diagnose a "penetrating" or "perforating" ulcer. Changes such as those mentioned would be necessarily fairly constant for any one ulcer over a short period of time. Forrsell and other workers however have noticed that changes in the appearance at the site of an ulcer may be found which are too essentially/

essentially transient to be due to any local organic condition, and they adduce strong evidence in favour of the occurrence of localised spasm of the muscularis mucosa due to irritation from the ulcer and resulting in "pouching up" of the mucous membrane around the irritative spot.

Diagrams are given in Fig. 19 to illustrate this theory. They are from those shown by Forrsell in (33) commenting on STROM'S paper.

It is obvious that, owing to the disappearance of all spastic phenomena under general anaesthesia, there is here an explanation of the discrepancy between the radiological and operative findings.

Forrsell's work is confined to stressing the occurrence of the spastic changes in duodenal, jejunal and gastro-jejunal ulcers but A. E. BARCLAY (34) suggests their presence in gastric ulcer without however giving any evidence for spasm as a causal factor in preference to the well known organic changes.

The above mentioned work has received very wide acceptance and has two very important applications in clinical work.

In the first place it very largely invalidates work such as that of MACLEAN (35) in which the "healing" of an ulcer under medical treatment is controlled by X-Ray/

X-Ray examination. If the "niche" is largely the result of spastic changes at the site of a shallow ulcer, then disappearance of the niche has no significance other than indicating an alleviation of the grosser irritation and can in no way be taken as proof of healing.

Conversely the fact that an "acute" ulcer is in itself too shallow to produce a niche does not render impossible its demonstration by X-Ray examination. Whatever may be the case in gastric ulcers the evidence of spastic elevation of the mucosa is exceedingly strong in ulcers of the small intestine and at the site of a gastro-enterostomy anastomosis.

(36)  
CARMAN and the majority of surgical writers on this subject have started with the premise that gastro-jejunal ulcers must necessarily be impossible to demonstrate radiologically by reason of their normally shallow structure.

Prints from three representative cases are shown.

In Case 20 a "niche" could be made out at the site of the stoma. This was most prominent at the screen examination and is not well demonstrated in the reduced prints but the residual flake after 6 hours is well seen. In this case operation revealed a relatively shallow anastomotic ulcer, apparently insufficiently deep to produce a niche such as that demonstrated.

In Case 21 the niche of a gastro-jejunal ulcer can be very clearly seen, but is of interest as there is here obviously mucosal elevation around the ulcer. At operation the edges of the ulcer were raised by indurative changes but it is doubtful if the ulcer was as deep as shown in the X-Ray film - i.e. there may here have been some superimposed spasm of the muscularis mucosae.

In Case 22 four prints are given. Here there is an appearance giving every evidence of a true "niche" sign, which included very sharply localised tenderness. After four weeks (Fig. 23) on Sippy treatment the patient had improved and no evidence of any ulcer could be made out, other than some contraction of the rugae at the site where previously the niche had been present.

The healing of a chronic gastric ulcer takes place by a fairly rapid filling of the ulcer crater by granulation tissue. This will cause a loss of the niche sign, but it is not until this has been replaced by fibrous tissue that the process of healing can be considered complete.

As previously indicated there are two routes by which the gastric contents may leave the stomach which/

which may be regarded as normal.

The food may leave by the stoma and pass into the efferent jejunum; such a course is always found in some degree and, in the cases showing a good result, the greater part of the food is going this way.

But the fact that a fair quantity is leaving by the pylorus and passing readily from the afferent to the efferent jejunum does not appear to militate seriously against a good result. Any departure from these routes may be regarded as abnormal and if occurring to any great extent is exceedingly likely to give rise to symptoms. In a certain number of "normal" cases however a small quantity of opaque food has been seen to leak into the afferent loop from the stoma at a time when the bulk was passing freely into the efferent jejunum.

There are thus five courses open to the gastric content all of which are to be considered abnormal to a definitely pathological extent, and deserving of the term "vicious cycle".

- (1) The food may leave by the pylorus but fail to reach or pass the anastomosis and be regurgitated into the stomach.
- (2) Again the food may leave by the pylorus and re-enter the stomach by the stoma.
- (3) Having left the stomach by the anastomosis the food may enter the afferent loop and re-enter the stomach by the pylorus.
- (4) The food having left the stomach as in (3) lies in/  
in/

in the afferent loop and is ultimately passed back into the stomach or on into the efferent loop.

- (5) Theoretically there may be a regurgitation of the contents of the efferent jejunum into the stomach.

While the opaque meal examination by means of X-Rays is probably the most accurate means of investigating the occurrence of these vicious cycles, it is very frequently a matter of great difficulty to be certain as to exactly what is happening. This is very largely due to the rapidity of movement which takes place under violent peristaltic activity and because it is so seldom possible to be certain that food has re-entered the stomach, as it becomes immediately lost in the opaque material which has not yet left.

The course described under (1) is that most commonly seen in cases of vicious cycle examined. It was present to a varying extent and was most prominent in a case (Fig. 16.) in which there was kinking of the afferent and efferent loops

In this case there was great dilatation of the duodenum which indeed, with the backward passage of food, are absolutely constant features of all cases of vicious cycle.

- (2) While it is exceedingly likely that food does sometimes pass from the afferent loop through the stoma, /

stoma, it has not been found possible to be certain whether this took place or not, the difficulty being that, while the afferent content is seen to disappear, there is no means of telling whether it has joined the efferent stream or remaining stomach content. This point is stressed because it is this type of vicious circle that is said by Moynihan to be the most serious and it is obviously important to establish to what extent it can be diagnosed or excluded by X-Ray examination.

(3) In several cases the barium was definitely seen to pass through the anastomosis into the afferent loop and to return to the stomach by the pylorus. In one of these about half a glassful of "fluid barium" was given and observed to pass immediately into the much dilated afferent loop. The stomach was momentarily empty and then became refilled by the passage of the barium through the pylorus.

(4) While as has already been mentioned a slight leakage of food from the anastomosis into the afferent loop is so frequent as to be not a true vicious circle, there can be no doubt that when this occurs to any marked extent it is liable to give rise to symptoms.

(5) Regurgitation of the contents of the efferent loop into the stomach may occur but has not been seen in/

in any of the cases examined in this series but, for the same reasons cited in (2), it may occur and be unobserved. From the rapidity, however, with which the food traverses the proximal jejunum in the majority of cases it would appear to be exceedingly unlikely.

The mechanism by which these aberrant routes take place is exceedingly interesting, as it has usually been assumed that reverse peristalsis is necessary for the passage of food along the intestine in the wrong direction.

Referring to duodenal ulcer H. J. PATERSON (37) writes:-

"On more than one occasion, by means of  
"X-Rays, I have been able to see this  
"reverse peristalsis, commencing at the  
"site of the ulcer, and, as it were,  
"shooting the duodenal contents back  
"into the stomach."

(38)

BECLERE throughout his book on the duodenum refers repeatedly to "antiperistalsis" in the obstructed duodenum.

Indeed references to reverse peristalsis are exceedingly numerous throughout radiological literature, and the possibility of its occurrence has apparently never been questioned. However at no time, either in the stomach or small intestine have I seen peristaltic waves moving in a proximal direction. In the series of vicious cycles examined the backward passage/

passage of the food always appears to be due to one or two mechanisms. The commoner is for hyperperistalsis in the normal direction to be seen forcing the barium to a point at which there is no free passage, thus causing a rapid rush of the food in the opposite direction. That such a mode of action occurs is beyond question and is what is meant when reverse peristalsis is mentioned. I owe to Dr. J.M. Woodburn Morison the suggestion that the so-called reverse peristalsis admits of no explanation on physiological grounds; that a reversal of all the normal innervation for peristalsis would be required, and that this is almost beyond conception. It is well known that peristalsis is independent of any central nervous control, but is abolished by producing a paresis of the myenteric innervation by nicotine, the normal action of peristalsis being thus apparently a local reflex action, with the presence of food as a probable stimulating factor. A total reversal of the reflex arc would be needed to produce true antiperistaltic action and it is difficult to conceive of this taking place.

The second action referred to is probably only an extreme degree of hyperperistalsis. It consists in what would appear to be a tonic spasm of a length of intestine. The afferent loop of jejunum is seen to become/

become filled with opaque food, there is an exceedingly rapid contraction of the whole loop and the contents are violently expelled backwards into the stomach. But this would appear to be merely a further degree of the "recoil" movement described already and analagous with the mechanism of vomiting as seen in the stomach in pyloric stenosis of sudden onset.

There is one other failure of the movement of the contents of obstructed small intestine which is very frequently seen. That is a rapid "to-and-fro" swing which is well seen on the fluorescent screen and is invariably a sign of some obstruction. This is simply due to a mass of barium recoiling after being forced against an obstruction until it reaches a point where it again meets with a peristaltic wave and is carried forward.

The conditions that may give rise to the establishment of a vicious cycle are cited by CHEUMSKIJ (39)

- (a) Close apposition of the jejunal loops causing a kink at the site of the anastomosis.
- (b) Kinking at the duodeno-jejunal flexure resulting from the operation.
- (c) Large mucosal folds closing the afferent loop.
- (d) Closure of the opening by union from faulty operative technique.
- (e) Compression of the efferent loop by the colon.
- (f) Narrowing of the opening in the mesocolon constricting the efferent loop.

(g)/

- (g) Antiperistaltic anastomosis of the jejunum favouring regurgitation.

It will be seen that, with the exception of (d), none of these lend themselves to discovery by X-Ray examination; nor indeed was any cause discovered in any of the cases of vicious cycle examined in this series of cases.

More and more attention is being paid to the possibilities provided by opaque meal examination in the early diagnosis of carcinoma of the stomach. While this diagnosis may be made at a very early stage by the observance of a defect in the normal peristaltic activity, in the vast majority of cases the patient is not seen until there is a definite filling defect in the normal gastric contour providing unmistakable evidence of malignancy.

It is indeed becoming appreciated that, with adequate care, the radiological examination is the most dependable of all means of diagnosing gastric new growths. Yet such is the condition of the stomach after gastro-enterostomy that there is a great likelihood that even an extensive neoplasm will be missed; moreover it is usually quite impossible to exclude the presence of such a tumour should one be suspected.

This was first appreciated fully when examination of a stomach, in which a palliative gastro-enterostomy had/



had been done for pyloric carcinoma, showed no evidence of the filling defect which had been conspicuous prior to the operation. Here but for the history, the stomach might, after operation, have been reported as showing no evidence of any lesion.

Fully 60% of stomach cancers occur in the pyloric region and are diagnosable by the filling defect which they produce there. Now it has been shown that it is a common occurrence for the distal portion of the stomach not to fill out at all after gastro-enterostomy with a large and patent stoma; so that a filling defect in this region ceases to have any diagnostic value in such a case. Moreover it is only to be expected that in just these cases with cancer there will be a patency arising from the neoplastic infiltration such as is seen at the pylorus. It would certainly appear to be important to emphasise the fact that a negative report of carcinoma of the stomach after gastro-enterostomy is of no value.

The added difficulties of diagnosis arise when it is realised that there will be no symptoms arising from obstruction until such time as the growth invades the anastomosis; and again that a hypochloridria can have no diagnostic value, being frequently found after an anastomosis has been made.

"E" - Conclusion.

An attempt has been made to show that the radiological examination is of some value in the investigation of gastro-enterostomised stomachs, and that the demonstration of a niche is possible in cases of gastro-jejunal ulcer, this being contrary to generally accepted views.

It remains to examine what help the radiological findings give in respect of the treatment of cases developing symptoms after this operation.

(40)

Moynihan states:-

"The treatment of jejunal ulcer is very  
 "difficult. I have no knowledge of an  
 "undoubted case in which symptoms have  
 "disappeared entirely and have long  
 "remained absent after medical treat-  
 "ment. The immediate results of medical  
 "treatment are good, but relapses are  
 "perhaps invariable. This is exceedingly  
 "disappointing for the surgical treatment  
 "of this condition is apt to be difficult,  
 "and it is attended by a danger greater than  
 "that which attaches to the original operation!"

There is in the first place, no general agreement as to the exact way in which a gastro-enterostomy confers its benefits. The "mechanical" view is that most widely held- this maintaining that the operation is purely one of drainage. On the other hand there are those who uphold a physiological action, in that the bile and pancreatic juices enter the stomach, reducing the hyperchlorydria which is possibly the basal/

basal factor in the initial lesion.

There are many arguments against the latter view but it would, on the face of it, appear paradoxical that the entry of food content from the afferent loop into the stomach should be regarded as one of the most disastrous sequelae to the operation, and yet its beneficial effects be considered as due to a similar passage of the digestive contents of the loop.

As has been said, all the radiological evidence points to the anastomosis having a purely drainage action, the actual rate of exit, however, possibly being controlled by the gastric tone. Yet in only a minority of cases is the anastomosis found to be placed at the site most suitable for drainage - the lowest point of the greater curvature. It has, however, been shown that very adequate drainage will occur in the recumbent position almost irrespective of the situation of the stoma.

No very extensive work appears to have been done in the way of analysis of the gastric content after operation.

(41)

BONAR using the Rehfuss test meal examined one hundred cases after gastro-enterostomy. He does not, however, give any figures for the fasting juice, either in volume or acidity, nor does he state the posture/

posture of the patients prior to the examination, thus, as the preceding remarks will have shown, introducing a very serious source of error. Bonar's findings however showed the constant presence of a hypochlorydria or achlorydria in every one of the cases examined and bile was frequently present. This, to a certain extent corroborates the radiological findings and further raises the interesting question of the aetiology of ulcers developing in the stomach, duodenum or at the anastomotic edge after operation.

While it is well known that hyperchlorydria can not alone produce ulceration its digestive action is generally considered necessary for the production of a deep chronic ulcer such as that shown in Fig. 24. The hypochlorydria subsequent to gastro-enterostomy has been considered as due to a diminished secretion following removal of the stimulating factors, such as the presence of food in the stomach for normal or longer periods, and to neutralisation by the alkaline intestinal secretion. The radiological findings would suggest that there may well be normal or even excessive secretion of acid which, owing to continual leakage through the anastomosis, will give no evidence of its presence by test meal examination. This would also serve to explain the frequency of ulceration/

ulceration at the anastomotic line and proximal jejunum of the efferent loop.

There would also appear to be a striking similarity in the rationale of the surgical technique and the modern medical dietries employed in the treatment of gastric and duodenal ulceration.

These dietaries in all their modifications have, as a constant feature, the administration of numerous small folds of some anti-acid food substance.

These are continued as frequently as is feasible during the night. Such treatment obviously tends to have just the result that would be obtained from a well performed gastro-jejunostomy allowing of the constant escape of acid gastric juice.

If the fasting period of approximately twelve hours during the night is considered to have a deliterious effect in such cases, the radiological findings receive strong clinical confirmation. Because while there is every evidence that the stoma gives a simple drainage effect, yet the degree of improvement following on operation is by no means proportionate to the degree of drainage produced in the stomach while the patient remains upright. Indeed the anastomosis is very rarely found at the lowest point of the greater curvature. Radiological examination however/

however demonstrates that, whatever the position of the anastomosis on the posterior wall of the stomach there is adequate drainage while the patient remains in the recumbent position, which may be assumed as the normal posture of the patient during his longest fasting period, and that in the fasting stomach there is a patulous condition of the stoma,

These observations would appear to point to two important points in treatment.

Firstly the great importance which simple rest in bed must have as a measure of post-operative treatment after gastro-enterostomy. It would also seem only reasonable that this period of rest should not cease abruptly but that the patient should be encouraged to lie down for some twenty to thirty minutes after meals over a considerable period, and that he should be instructed to do this on the slightest reappearance of his previous symptoms. Great importance has lately been attached to adequate post-operative care of the patient and <sup>(42)</sup> MOYNIHAN in emphasising this, states that all his patients receive a printed form comprising eight cardinal rules to be followed.

There is however no mention of the benefit to be derived from a measure so essentially simple as that described.

The second point is that both test meal and radiological/

radiological examinations would appear to indicate that a rigid adherence to any of the severe dietetic systems devised for the treatment of duodenal ulcer is contra-indicated in a case of gastro-jejunal ulcer. When there is already a hypochlorydria and adequate drainage the stopping of all normal food can only serve to increase the existing weakness of the patient. More especially is this apparent in the light of BOLTON'S<sup>(43)</sup> work which points to a hydrochloric acid content of less than '1% having little or no deleterious action.

It is not intended to suggest that the normal food should be taken but that rest in bed and a non-irritating dietary sufficient to maintain the patient's strength would appear to be adequate. Yet in the great majority of instances patients have come to a second operation after a "failure" of medical treatment where this has been attempted while the patient was following his usual work.

Turning now to the question of vicious cycle it may be mentioned that there is very little difficulty in differentiating this complication from that of post-operative ulceration, even without a radiological examination. In the latter case there is seldom, if ever vomiting while this is to a greater or less extent always a feature in cases of vicious cycle.

Whether/

Whether in any one case the cause of this condition be a malformation of the anastomosis or some form of traction ileus there is apparently little to be done in the way of medical treatment.

D. P. D. WILKIE <sup>(44)</sup> has drawn attention to the frequency of duodenal ileus following gastro-enterostomy and his work <sup>has</sup> been widely confirmed. (45)

It is a well known symptom and is indeed only logical that the ileus disappears on the patient lying down. This occurs when the cause is compression by the superior mesenteric artery, middle colic artery or a peritoneal band. Here, and in the various forms of stoma deformity previously cited it is difficult to see in what way medical treatment can help. Competent authorities consider there is adequate reason to believe in the possibility of spasm of the anastomosis; the claim of the workers in Holzknecht's clinic to relax this spasm by X-Ray therapy has already been mentioned.

There is no more to be said of the diagnosis of gastro-jejunal ulceration than has been given in Part D.

I hope to have shown that, given suitable technique, the demonstration of these lesions is more probable by radiological means than is generally indicated.

Any accurate statistical survey of the series of cases here reported on, is impossible in as far as it bears on the value of the radiological examination.

This/

This is due firstly to the varying degree of exactness with which the radiological reports were given, and secondly to the very natural reluctance of the surgeon or physician to submit these patients to a second operation.

However in reviewing forty two consecutive cases which were sent for X-Ray examination because of gastric trouble subsequent to gastro-enterostomy an attempt has been made to classify these under -

- (1) "Definite Diagnosis".
- (2) "Indefinite Report" and
- (3) "No Abnormality Detected".

Under (1) are included these cases in which it was considered possible to state the nature of the lesion present.

Under (2) are classed cases in which the examination indicated some organic lesion or disorder of function, but in which it was not considered possible to be at all dogmatic.

- (1) In eighteen cases a "definite" diagnosis was made. Of these, eleven came to operation, the radiological findings being confirmed in ten. The remaining case was one in which a gastric ulcer had been diagnosed but none could be found on laparotomy. Under this class are included five cases of vicious cycle, two of which underwent/

underwent operation, although in no case was the exact cause of the condition stated.

(2) In eight cases an "indefinite" diagnosis was given. Two of these came to operation in both of which gastro-jejunal ulcers had been suggested. In neither case was an ulcer present, there being however peri-stomal adhesions.

(3) In nineteen cases no radiological evidence of any lesion or functional abnormality could be found. As far as is known only one of these was operated on but in nine cases it has not been found possible to trace the patient. In the single case referred to, a large pre-pyloric carcinoma was found at operation. The way in which such a condition may escape detection has been mentioned.

The cases mentioned above are only those which I have personally examined.

"F" - SUMMARY:

- (1) An account is given of the technique found most suitable for the radiological examination of cases after gastro-enterostomy.
- (2) The mode of filling and action in the normal stomach, and after gastro-enterostomy is described.
- (3) It is suggested that there is a patulous condition of the stoma in the fasting stomach, allowing the leakage of the gastric secretion, especially in the recumbent position and that this may be at least a partial explanation of the improvement following gastro-enterostomy.
- (4) It is pointed out that in the full stomach there is a rhythmical action of the stoma, and that this is probably due to variations in the gastric tone.
- (5) As there is every evidence that primary union rarely takes place at the anastomotic line, puckering of the mucosa will normally be present and can have no diagnostic significance.
- (6) The only radiological evidence of gastro-jejunal ulcer is the actual demonstration of a "niche".
- (7) It is pointed out that while a well formed "niche" sign is diagnostic of gastric, duodenal or gastro-jejunal ulcer, the disappearance of this sign can in no way be taken as evidence that the ulcer has healed.
- (8) The diagnosis of carcinoma developing in a stomach after gastro-enterostomy is exceedingly difficult by the opaque meal, and it is suggested that the onset of symptoms will be unusually late. A negative X-Ray report of neoplasm in these cases is of no value.
- (9) In every examination of a stomach after gastro-enterostomy, mention should be made of the position of the colon, preferably in relation to that of the anastomosis.

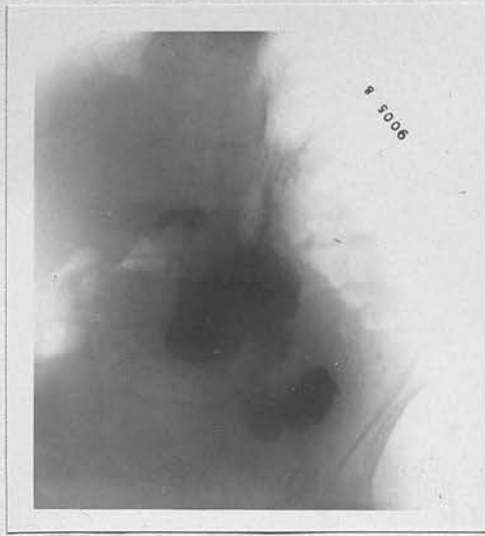
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A.

B.



6.9.28. Three months history of loss of appetite and weight.

Ba.Meal.6.9.28. Large very dilated stomach of fairly good tone. Owing to large amount of retained food it was difficult to be sure, but appearance is as of a prepyloric filling defect.

6 Hrs. Almost complete retention of the meal.

Operation. Prepyloric carcinoma. Gastro-enterostomy done preliminary to partial gastrectomy.

Ba.Meal.30.10.28. Food leaving well through the anastomosis. There has been very marked contraction of the stomach.

Note that in this case the gastro-enterostomy was done before there was much loss of tone. The apparent disparity in the bulk of the barium in the two examinations is due to the dilution of the barium by the retained gastric content at the first examination.

A. Before operation.

B. Seven weeks after operation.



Stomach of Semnopithecus.

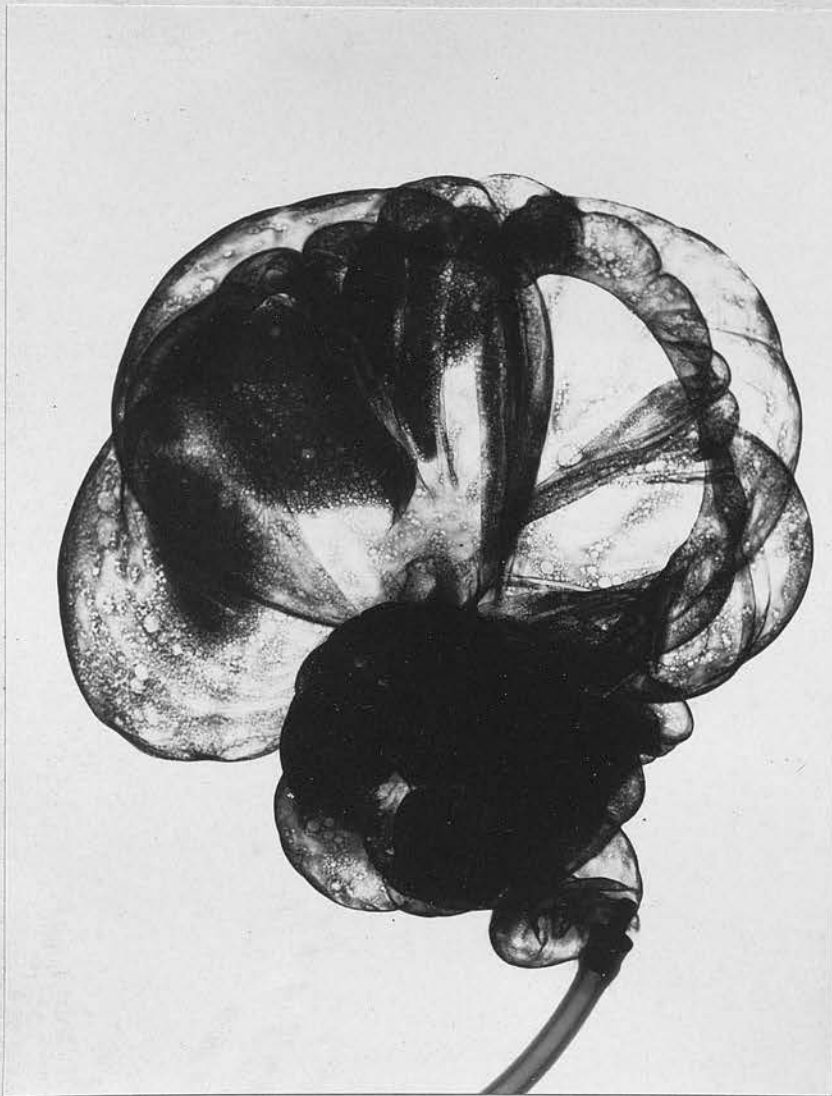
Prepared as in previous figure, but after division of the short band along the lesser curvature. The large proximal, and small distal tubular stomachs are well seen.



Normal Human Stomach,

A small quantity of barium and mucilage has been introduced, and the stomach lightly "massaged". The finer mucous membrane structure is visible towards the cardia, and the coarse deep rugae along the fundus.

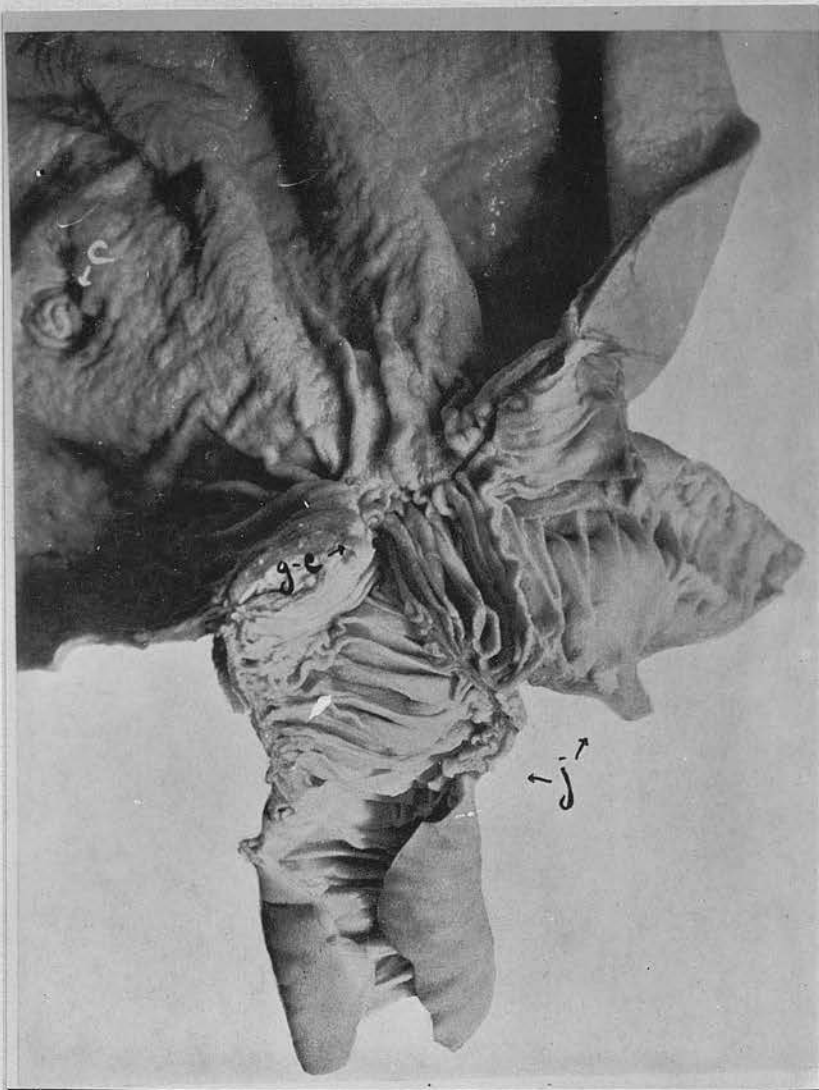
X Ray photograph after inflation.



Stomach of Semnopithecus.

Prepared as in previous figure of human stomach.

Stomach inflated in position as it lies in the abdomen.



Photograph of specimen shown by H. Hellmer.

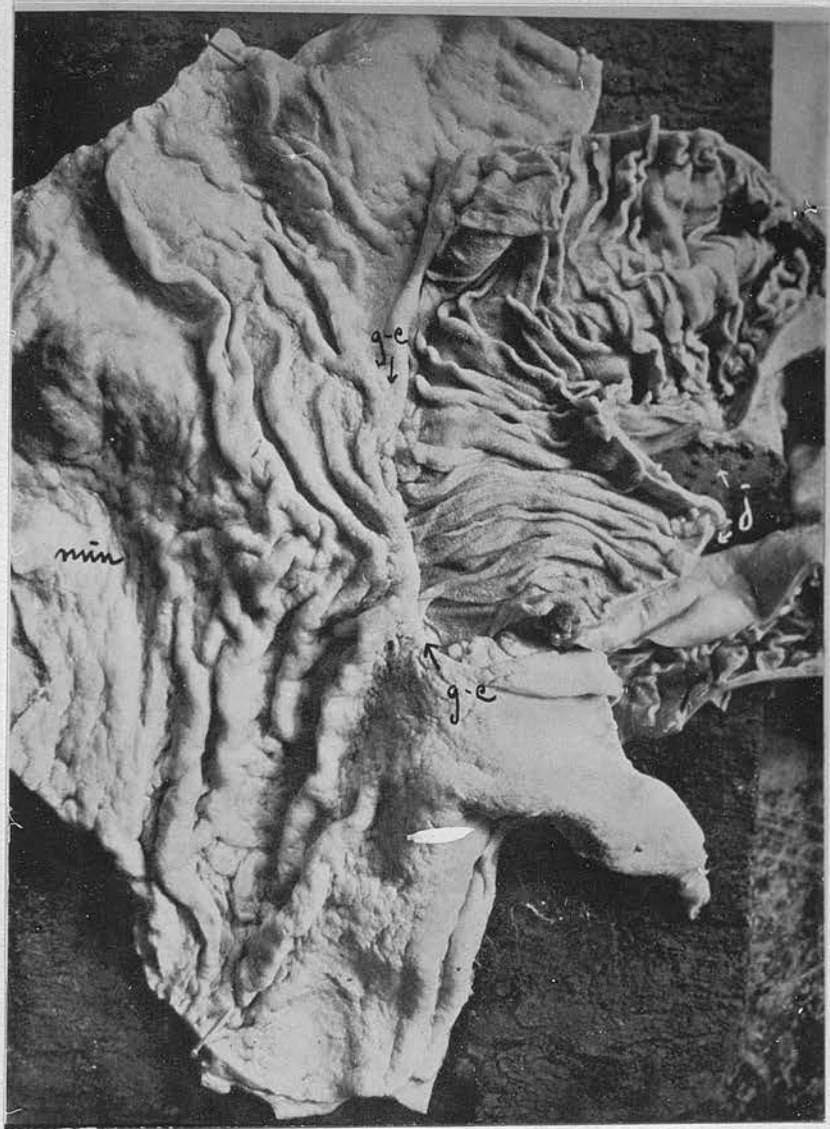
The great number of jejunal folds formed near the stoma is well shown. Hellmer considers that it is by virtue of these that complete spastic closure of the anastomosis is possible.

The convergence of the gastric rugae is again seen.

The specimen was obtained from a patient who died twenty four hours after operation for pyloric carcinoma. Hellmer writes of this case:-

"Cette augmentation est meme si prononcee vis-a-vis l'orifice, qu'il semble s'elever un veritable bouchon muqueux contre cet orifice."

Figure. 8,



Photograph of specimen shown by H. Hellmer.  
The convergence of the gastric rugae to one point of the anastomotic ridge is well seen.  
The specimen was really taken as demonstrating the increase in the number of folds in the small intestine which is found in the vicinity of the stoma. This is also well shown in the next figure.  
The case was one in which the patient died one month after operation for prepyloric carcinoma.



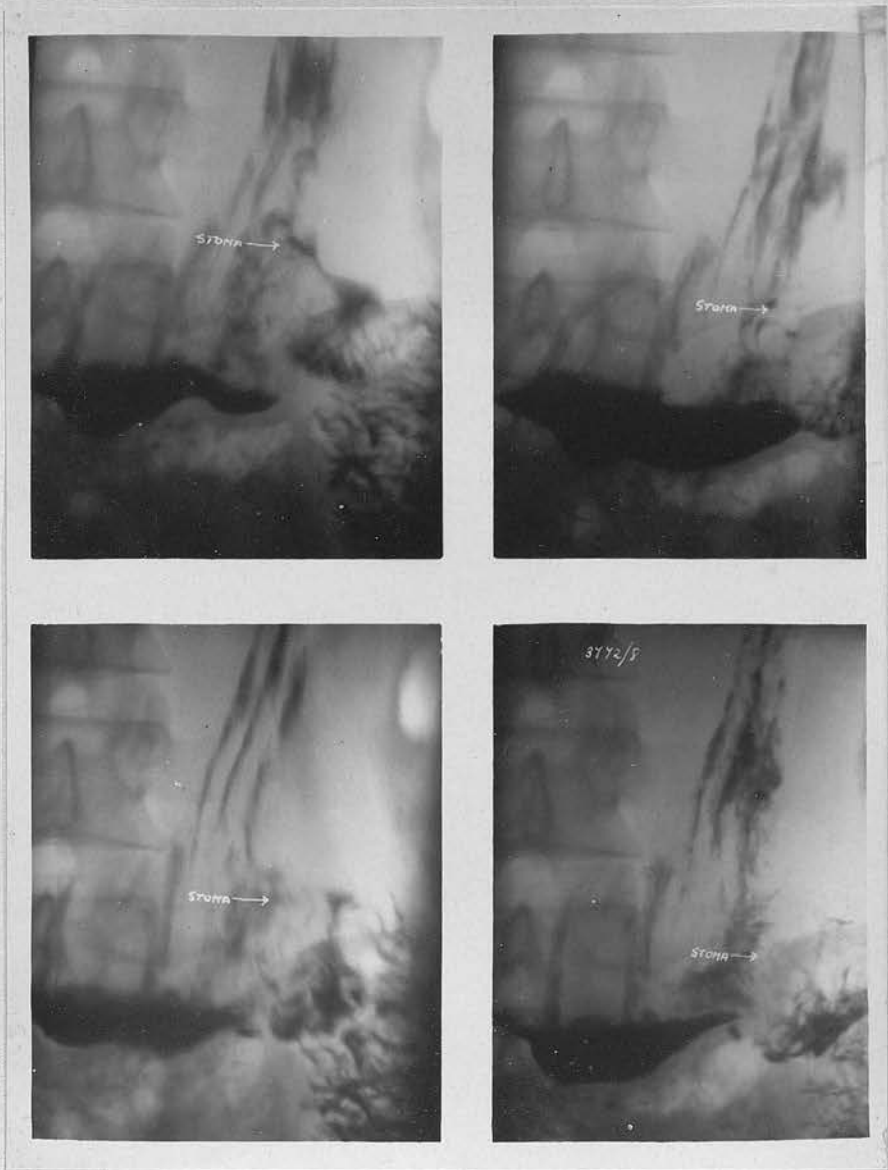
Ba.Meal.20.6.28.The examination is strongly suggestive of duodenal ulcer.

Operation. Duodenal ulcer.Gastro-enterostomy.

3.10.28.Patient has had pain and constant vomiting since the operation.

Ba.Meal. There was a well marked vicious cycle, a considerable amount of the food entering the afferent loop by the stoma and returning to the stomach by the pylorus.No deformity of the anastomosis could be made out.

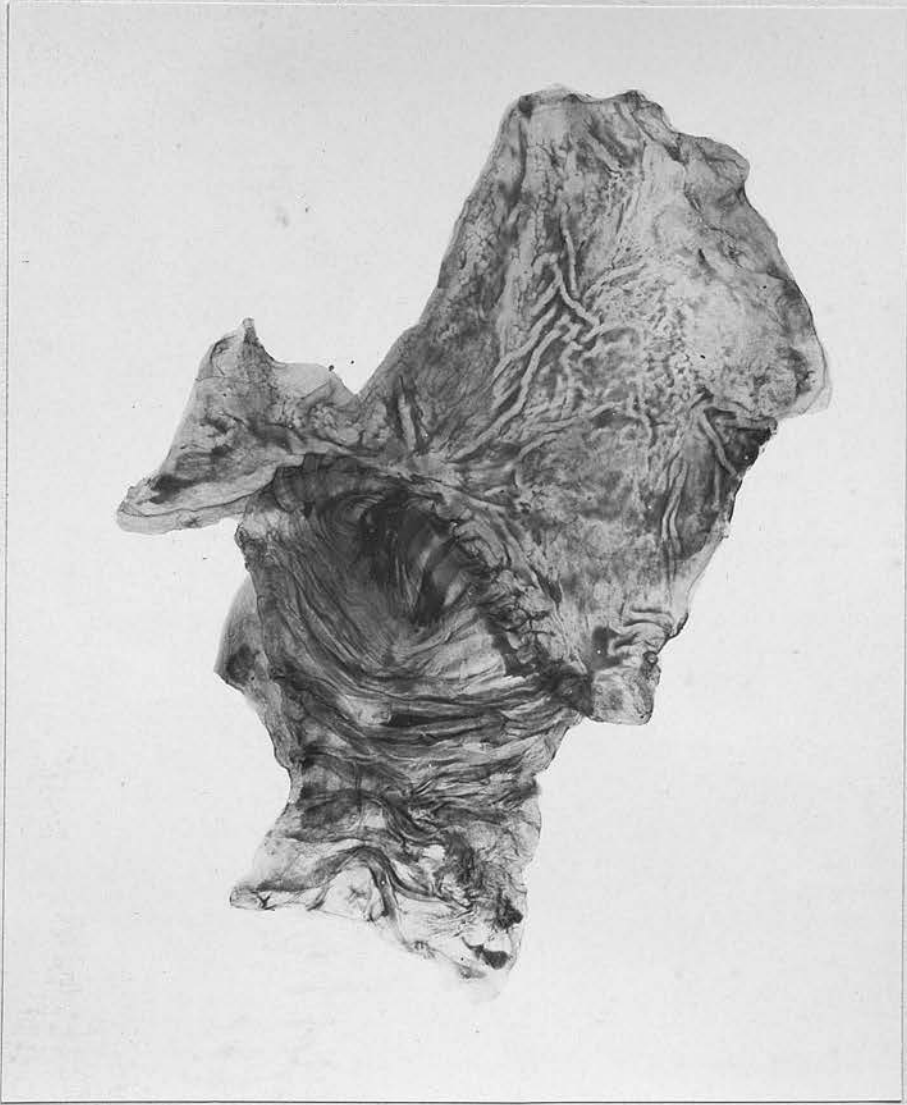
The prints made from four "serial"films show well the apparently normal stoma,the greatly distended afferent loop (A.L.)and only a small quantity of barium entering the efferent loop.



Ba.Meal.22.11.26. Deformed tender cap---Duo.Ulcer.  
 Operation. Gastro,enterostomy for duodenal ulcer.  
 Recurrence of symptoms.

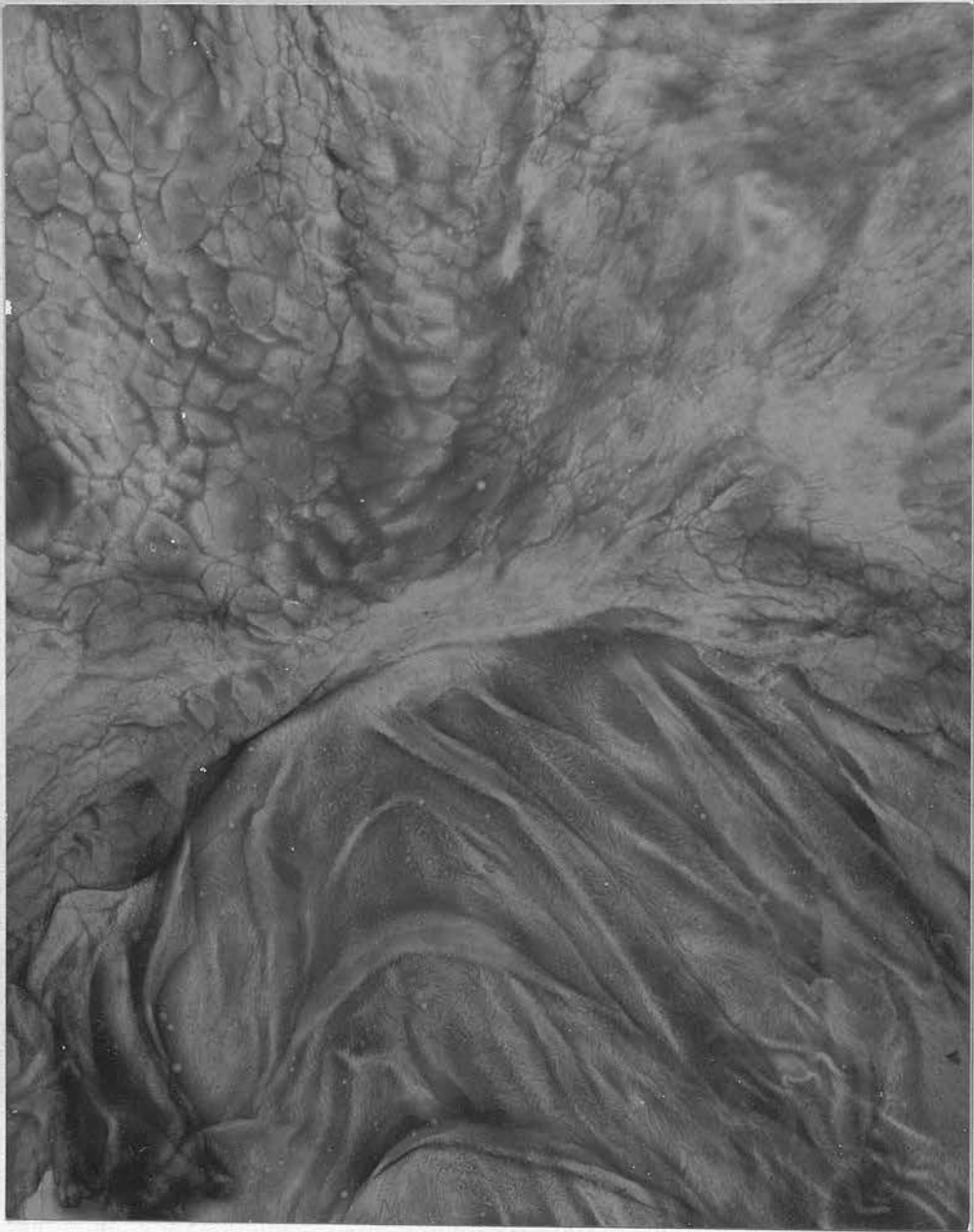
Ba.Meal. 14.10.28. Serial films (above) of stoma  
 show small dense persistent flake of  
 barium at site of edge of the anast-  
 omosis, there was intense tenderness  
 localised to a spot overlying this area.  
 Diagnosis. Gastro-jejunal ulcer.

Clinical Diagnosis. Gastro-jejunal ulcer.  
 Patient left hospital without permission.



X ray photograph of line of anastomosis, from specimen obtained at post-mortem, the patient having died seven days after operation from intercurrent infection.

The sutures which were quite unabsorbed are well seen. There was no union of the mucous surfaces, and only a slight degree of healing of the deeper structures.



Enlargement from X ray photograph of line of anastomosis. To the right and left the gastric and jejunal mucous membrane are seen to be confluent ---healing by primary union.

In the centre a ridge of fibrous tissue is seen towards which the folds of the mucosa converge, here there has been delayed union producing an appearance as of a chronic cicatrizing gastro-jejunal ulcer.

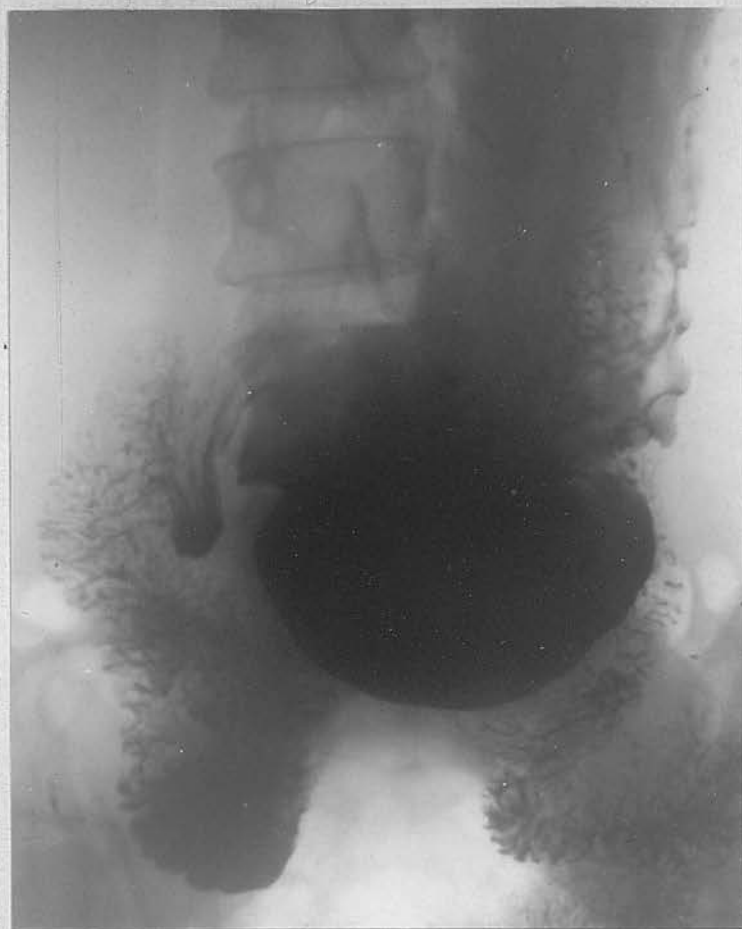


Print from serial film of normal gastro-enterostomy.

Note the gastric rugae are well shown converging to the anastomosis.

The "pool" of barium frequently found in the efferent loop (page 36) is seen.

Note that film has been taken with the patient upright and that the barium has only left down to the level of the stoma.



Operation 1924. ? ? nature.

" Feb. 1928. Gastro-enterostomy.

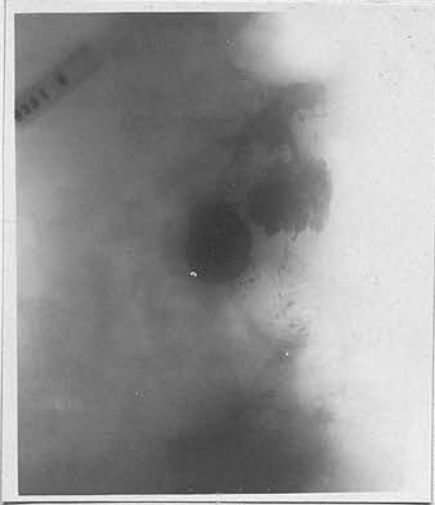
Ba. Meal. 5.6.28. Very vigorous peristalsis, but no food leaving by the anastomosis.

On palpating a small amount of barium through the pylorus, this appeared to have some difficulty in passing the anastomosis.

Duodenum and jejunum dilated.

Operation. 12.6.28.

Duodenum and jejunum found to be very dilated. Anastomosis normal but the afferent and efferent loops were constricted by the opening in the meso-colon causing sharp kinking at the anastomosis.



Operation. 9.7.20. Anterior gastro, enterostomy to both sacs of hour, glass stomach with anastomosis between jejunal loops.

Patient remained well until Sept. 1928.

Onset of epigastric pain and vomiting.

Ba. Meal. 28.10.28. The barium divided into two streams immediately below the air cap of the stomach, a very narrow stream filling out the distal sac of the stomach. The proximal jejunum showed very marked dilatation. The food remained in the stomach for more than twenty four hours.

Operation. The old anastomosis to the distal sac of the stomach was found to be closed, the patient's symptoms being apparently due to tetany from advanced stasis of gastric content. No cause could be found for the jejunal dilatation.

Gastro-enterostomy done but patient died from broncho-pneumonia.

Post-Mortem. Operative and radiological findings confirmed.

Figure.18.

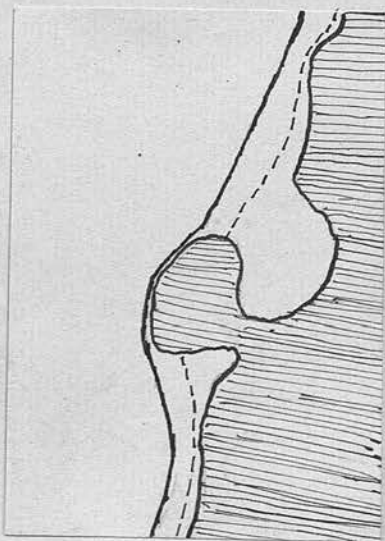
A.



B.



C.



Reduced prints of large penetrating gastric ulcer, and well defined duodenal ulcer. Note "indrawing" of gastric wall immediately above niche in A.

Diagram C is intended to show probable mode of formation of the niche.

Continuous line represents approximate outline of serous coat of stomach.

Dotted line represents inner limit of muscular coat, there being thus a high ridge around the ulcer crater, certainly oedematous, probably also partially spastic in origin.

Figure 19 refers to formation of ulcers as in B.

Figure. 19.

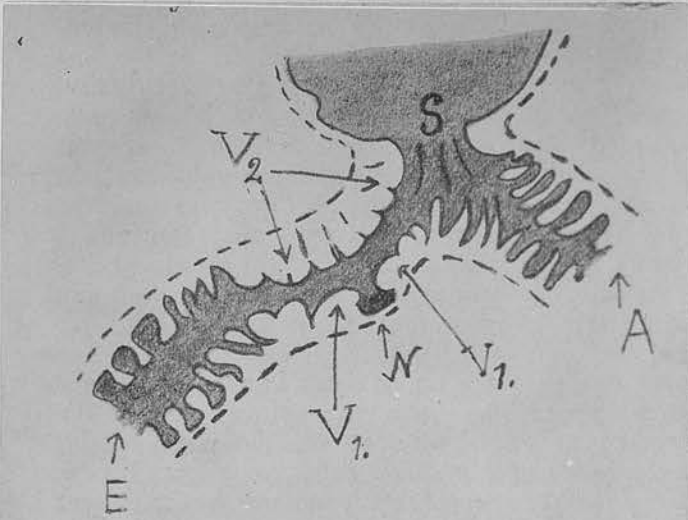


Fig. 1. S = the stoma of the gastro-entero-anastomosis; A = the afferent jejunal loop; E = the efferent jejunal loop; N = the niche;  $V_1$ — $V_1$  = high folds of the mucous membrane, surrounding and forming the niche;  $V_2$  = high and broad folds, closing up together and forming a cushion that protrudes into the lumen. The dotted line indicates the probable outline of the stomach and the jejunal loop in the vicinity of the gastro-entero-anastomosis.

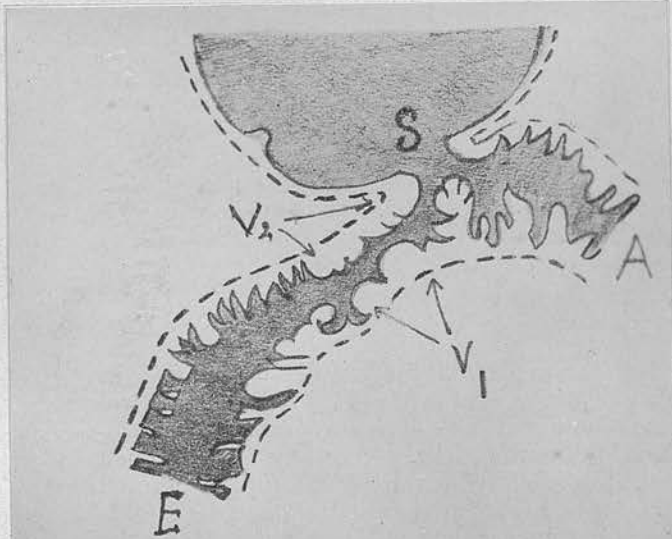


Fig. 2. The same notations as in Fig. 1, but the ulcer is in this case not visible in the roentgenogram, only the broad folds in its neighbourhood.

Reproductions from diagrams shown by Forrsell, cited on page 46. These were reproduced from two negatives of an actual case of gastro-jejunal ulcer, and are intended to show the way in which the high folds of mucosa (possibly spastic in origin) may be the only radiological evidence of an ulcer, even when a crater is present.

A.



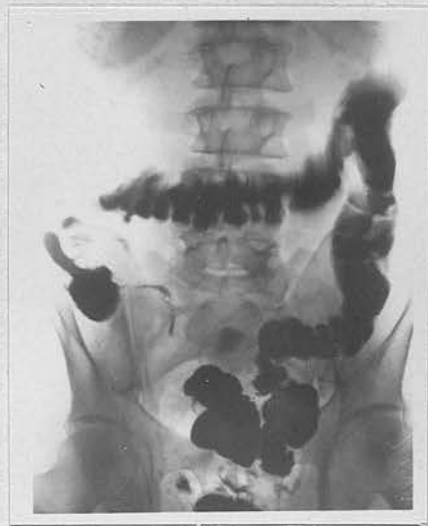
B.



C.



D.



Castro-enterostomy for duodenal ulcer.

Recurrence of symptoms.

Ba. Meal examination. Ulcer niche at site of stoma.  
At this site there was a residual flake  
after six hours. After twenty four hours  
the transverse colon is seen to cross the  
area of the ulcer.

Operation.

A deep penetrating ulcer was found at the  
line of the anastomosis, adherent to and  
involving the transverse colon.

The patient was too stout to demonstrate the niche  
formation clearly on the film.

A. and B. First exam. upright. C. Residual flake after  
Six hours. D. Colon filled after twenty four hours.

A.



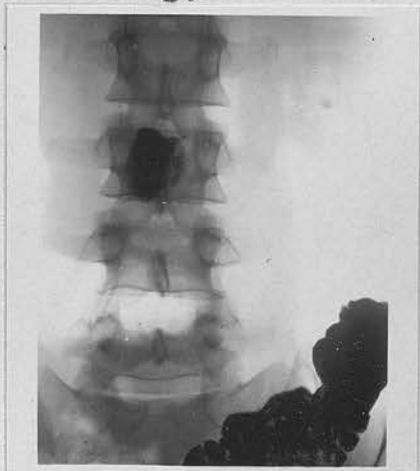
B.



C.



D.



A. and B. show a well formed niche, the ulcer being in the jejunum immediately beyond the anastomosis. Films taken in upright position.

C. recumbent. The folds of the mucosa are well seen curving into the ulcer.

D. Large residual flake of barium in colon after twenty four hours, corresponding to area of ulcer.

Diagnosis. Gastro-jejunal ulcer probably involving the transverse colon.

Operation. Gastro-jejunal ulcer with adhesions to colon. Also duodenal ulcer.

Note appearance as of pouching of mucosa around the ulcer, at operation this was found to be indurative.

A.

B.



C.

D.



Gastro-enterostomy 1920. Recurrence of symptoms 1927.

- A. Immediately after barium "drink", which has nearly all passed rapidly through the stoma.  
 B. Immediately after barium meal. Stomach filled.  
 C. Half an hour after barium meal.  
 D. Six hours after barium meal.

An ulcer "niche" is well seen in all the films situated exactly on the edge of the anastomosis. Over this site there was marked localised tenderness, with a residual flake after six hours.

Note the great distension of the jejunum in A. This dilatation has no significance after operation.

Compare with figure 23 which is of the same case.

A.



B.



C.



D.



Prints from four films of same case as in Fig.22.  
 after four weeks treatment by rigid "Sippy" diet.  
 Note complete disappearance of "niche" sign.

There had also been marked improvement clinically  
 under the treatment.

Note convergence of rugae to site of niche as seen  
 at previous examination, which may, or may not be due  
 to scarring from the healed ulcer.



Perforated duodenal ulcer. 22.2.26.

Gastro-enterostomy performed.

24.10.28. Losing weight, pain after food.

Ba. Meal. Very low atonic stomach, only a small amount of food leaving by the stoma which appeared to be about two inches from the lowest point of the stomach. Persistent projecting flake of barium high on lesser curvature

6 Hrs. Fairly large gastric residue, niche confirmed.

Operation.

Anastomosis satisfactory. Large excavating ulcer present on lesser curvature.



Ba.Meal. 1926. Prepyloric carcinoma.

Operation. Inoperable carcinoma. Gastro-enter-  
ostomy.

Ba.Meal. 16.6.28. Barium leaving well through stoma.  
Complete filling defect distal half  
of stomach reaching to anastomosis.

Operation. 20.6.28. Carcinoma now extending to the  
edge of the anastomosis and beginning  
to involve it. Further gastro-enter.  
done more proximally. Patient died.



Gastro-enterostomy in 1925.

Recurrence of symptoms. Clin. Diag. Jejunal Ulcer.

Ba. Meal. 23.2.28. Food leaving rapidly through anastomosis. No deformity of stoma seen. No antral formation, and no food leaving by pylorus, nor could any be forced through even on heavy palpation

6 Hrs. Small residual flake proximal to pylorus.

Pylorospasm present. No evidence of jejunal ulcer.

Operation. Anastomosis working well. Prepyloric ulcer found and excised.  
27.6.28.



Print made from one of serial films, showing formation of mucous membrane as seen by using mucilage and barium.

No abnormality could be detected at the anastomosis, the food left very rapidly by it, and the distal stomach did not fill out.

Castro-enterostomy had been done in 1921 for pyloric ulcer. Patient had remained well till July 1928, when he began to lose weight and vomit.

Operation:- Large carcinoma of distal stomach.

Note that here a tumour was missed at the examination which would have been obvious in an unoperated case.

Note also that the food in the stomach has left down to the level of the stoma.