

X RAY EXAMINATIONS

and

FRACTIONAL TEST MEALS

An investigation into their usefulness
in assisting in the diagnosis of functional
and organic disease of the stomach and duodenum

by

JOSEPH E. MACCABE, M.B., Ch.B.

INTRODUCTION

While I was House Physician at the Royal Sussex County Hospital in Brighton, I examined fractional test meals in forty patients.

In twenty eight of the same patients, X Ray examinations were done by the honorary Radiologist to the Hospital, to whom I am indebted for the radiological reports.

The cases were variable in sex, age and complaint. All, with the exception of two, had definite abdominal symptoms and cases of duodenal ulcer, gastric ulcer, carcinoma, chronic appendicitis, cholecystitis and gastritis were investigated.

The two cases without definite abdominal symptoms, were cases of Pernicious anaemia.

In sixteen of the cases operations were performed and it was then possible to verify the diagnosis formed and to prove the correctness or otherwise of the X Ray and test meal findings.

In three cases in which no operation was performed, haematemesis had occurred in two and internal haemorrhage in one.

In some of my cases I performed two test meals after a certain interval had elapsed and was thus able



to find any variations which had taken place as a result of treatment. In two of the cases of duodenal ulcer in which two test meals were performed, gastroenterostomy had been done and the effect this had on the gastric acidity was demonstrated.

In the radiological examinations the screen method was used as well as the taking of films and the examiner was supplied with a short history of the case together with the result of the clinical examination and the suspected diagnosis.

The test meal was the fractional method invented by M.Rehfuss M.D., (1) and the technique employed was that recommended by J.A.Ryle, M.D.,F.R.C.P.,(2)

The patients were also thoroughly examined and a careful history taken and tests for the presence of occult blood in the stools were also carried out in any case of suspected ulceration.

VALUE OF X RAY EXAMINATION.

Positive Value.

In the study of pathological conditions of the stomach and duodenum the positive value of X Ray examination is in the confirmation of the Physician's or Surgeon's diagnosis. In many cases, the X Ray not only confirms the diagnosis, but also affords additional valuable data; for example, in a case of ulceration of the stomach, it may show the depth and position of the ulcer and any deformity which the ulcer may be producing. The condition of hour glass contraction of the stomach, whether due to carcinoma or saddle shaped ulcer, can be more easily diagnosed by X Ray than by any other method of examination short of operation.

In cases of duodenal ulcer, any marked delay or rapid emptying of the bismuth meal can be noted. In cases of penetrating ulcers of the stomach it is possible by means of the X Ray to find out if the ulcer is healing. It is noted by the disappearance of the characteristic niche described by M.Haudek, M.D., (3) In cases of ulceration where it is impossible to demonstrate any niche, as the ulcer only involves the mucous membrane of the stomach, an expert Radiologist

can demonstrate the interruption of the rugae. Even after an ulcer is healed, G.H.Orton,M.D.,D.M.R.E.,(4) considers the X Ray can demonstrate the site of the healed ulcer by the transverse ribbing which is present.

In cases of carcinoma an opinion of the extent to which the lesion is involving the stomach can be formed and may help the Surgeon to decide whether an operation will be of any benefit to the patient.

The size, shape, position and peristaltic activity of the stomach can be studied.

The size of the organ may be found to be greatly increased, a marked dilatation of the stomach may be found and provided there is no possibility of there being any pyloric obstruction, the X Ray greatly assists the Physician in his diagnosis and also points the way to correct treatment.

The shape of the stomach may be altered as the result of adhesions to surrounding organs. This can only be diagnosed by radiological examination.

Marked ptosis of the stomach is easily recognised although it is now realised as the result of work done by Moody, Van Nuys and Chamberlain,(5) that the stomach very often occupies quite a low position even in health. Should the stomach be found below the ordinary health level, then ptosis can be diagnosed.

The muscular power can be studied. The peristaltic waves may be sluggish with consequent delay of the contents of the stomach.

The main point with regard to the changes in shape, position and motor power of the stomach, is the definite exclusion of any organic disease in the stomach, or duodenum causing these changes. According to T. Izod Bennett, M.D., (6) it is possible to diagnose hypersecretion, the juice being seen as a translucent layer deep above the opaque barium.

External causes of gastric or duodenal symptoms, for example gall stones, can now be diagnosed by the Tetra-Iodophenolphthalein method. Inability to demonstrate the appendix might lead to the suggestion of chronic appendicitis and explain many cases of gastric or duodenal symptoms, where it is impossible to demonstrate any pathological condition therein.

To sum up the positive value of X Ray, it may be said that if the radiological findings agree with the history and the results of clinical investigation, then the diagnosis may be accepted with a great degree of certainty; if it disagrees with the definite clinical diagnosis, then it must be accepted with reserve.

Negative Value.

From the point of view of negative value X Ray examination is of great use in differential diagnosis. In doubtful cases where the Physician or Surgeon is unable to come to any definite conclusion as to whether there is any pathological condition present in the stomach or duodenum, if the X Ray shows a normal outline of these organs, no interruption of peristalsis, normal position and no delay in emptying, then in all probability no lesion exists in either of the two organs. The result of such an examination to a certain extent, rules out either of these organs as being the cause of the patients symptoms.

In other cases where there is thought to be some definite lesion present in the stomach or duodenum, the X Ray may show that the organs are normal and at the same time reveal the cause of the trouble to be outside, for example, pressure of a tumour on one of the surrounding viscera. Expert Radiologists consider that if the X Ray does not show any lesion then the inference is that no lesion exists. This opinion must be accepted with great caution.

To sum up the negative value of X Ray it may be said that provided it does not contradict the clinical diagnosis, it is quite useful in helping a Physician

or Surgeon to come to some definite decision in a doubtful case.

Possible Falacies.

ULCER

1. Time of Examination in Relation to Symptoms of Ulcer.

In cases of gastric or duodenal ulcers, which are seen during the acute stage and which are not X Rayed until after the acute symptoms have disappeared, it is quite possible that the result of the X Ray examination will be negative. The ulcer in such cases may have been very small and as a result of the treatment rapid healing may have taken place. Even in cases where the ulcer is deep it may be impossible during the healing stage to demonstrate the niche.

F.N.White, M.D., (7) quotes a case in which the X Ray failed to show any ulcer crater, and this was found at operation to be due to the presence of food in the ulcer. E.Hollander, M.D., (8) had a case in which mucoid material was present in the crater, so that the crater could not be demonstrated by radiography. The same author points out the possibility of the niche being obliterated by pressure of the surrounding organs. W.W.Hamburger, M.D., (9) quotes a case in which granulation or scar tissue filled the ulcer so that the X Ray report was negative.

2. Distortion of Existing Condition.

F.N.White,M.D.,(10) had a case which shows this point very clearly. When X Rayed, the stomach showed smooth walls with active peristalsis and a deformed duodenal cap, which the Radiologist was not able to fill out under a long screen examination and a series of photographs. Very little of the meal had passed out in six hours, and half of it remained at the end of twelve hours. Duodenal or pyloric ulcer with stenosis was diagnosed, but the obstruction proved to be due to spasm and oedema associated with an ulcer near by. A.E.Barclay,M.D.,(11) points out that the radiogram may show what appears to be a penetrating ulcer of the lesser curvature, whereas it is a simple ulcer with heaping up of the mucous membrane around.

3. Diverticulitis of Stomach or Duodenum.

L.R.Broster,O.B.E.,M.D.,F.R.C.S.,(12) considers that diverticuli of the stomach or duodenum, are very liable to be mistaken for penetrating ulcers. The chief point of difference is the smoothness of the walls of the diverticuli as compared with the roughness of the walls of the penetrating ulcer.

A.E.Barclay,M.D.,(13) points out that diverticulitis of the duodenum is comparatively common and is more readily identified on the screen than on a film.

4. The Wrong Positive Diagnosis.

M.Rehfuss, M.D.,(14) affirms that material passing through the duodenal-jejunal flexure, may temporarily give rise to a suspicion of a niche like that produced by an ulcer; while W.W.Hamburger,M.D.,(15) quotes a case in which a peristaltic indentation was mistaken for a penetrating ulcer which was not found at operation.

A.E.Barclay,M.D.,(16) points out that marked deformity of the duodenal cap similar to that produced by an ulcer, may be caused by adhesions. If the Radiologist is unable to demonstrate the crater of the ulcer, (and this is at times very difficult,) he is unable to make an absolutely positive diagnosis. Again M.Rehfuss,M.D.,(17) had a case in which the marked contraction of the duodenum as shown by the X Ray, although very suggestive of ulcer, was entirely due to reflex spasm, the patient having a renal stone.

5. Wrong Negative Diagnosis.

A.E.Barclay,M.D.,(18) affirms that in certain cases of flat ulceration near the pylorus it may be quite impossible to demonstrate any abnormality.

CANCER.

The difficulties of demonstrating carcinoma and the fallacies for which the Radiologist must be on guard are many.

L.R.Broster, O.B.E., M.D., F.R.C.S., (19) considers that there is always a liability for confusion to take place between the picture produced by a duodenal lesion and that produced by a growth. M.Haudek, M.D., (20) points out the difficulty of diagnosing an ulcer of the lesser curvature near the pylorus, from early carcinoma of this area. He gives the following reasons -

(A) Ulcers in this area less frequently show niches.

(B) They are associated with more pronounced submucous oedema and an increased tendency to spasm of the gastric musculature.

(C) There is also a greater degree of mucous membrane swelling, so that the lumen of the pyloric part of the stomach is quite often narrowed, thus giving an appearance similar to that produced by carcinoma. He also points out the importance of remembering that ulcers in this area have a marked tendency to undergo malignant degeneration.

A.J.Walton, M.S., F.R.C.S., (21) considers that the X Ray does not give any sign of the early changes, which an ulcer undergoes when becoming malignant, while T.Izod Bennett, M.D., M.R.C.P., (22) holds that a picture of filling defect of the stomach similar to that produced by carcinoma, may be caused by a chronic peptic ulcer. The same author observes that it is sometimes

impossible to tell by X Ray alone, whether hour glass contraction of the stomach is malignant or otherwise.

M.Haudek,M.D.,(23) gives the following causes which produce a similar picture to carcinoma.

- (1) Non-malignant thickening and contraction of the walls of the stomach.
- (2) Regional gastrosperm - (cause unknown.)
- (3) Circumscribed Fibromatosis.
- (4) Syphilis.

M.Rehfuss,M.D.,(24) quotes a case in which the picture of filling defect of carcinoma of the antrum was produced by pressure of an enlarged gall bladder. (The clinical examination suggested gall bladder trouble.)

Wrong Positive Diagnosis.

M.Haudek,M.D.,(25) states that retained secretion (and M.Rehfuss,M.D.,(26) food in the stomach) interferes with the state of the mucosal relief pattern. It may also produce a filling defect which might be mistaken for that of carcinoma.

A.E.Barclay,M.D.,(27) points out that even in a normal stomach, the outline of the greater curvature may be crenated, giving the appearance of the jagged inroads of an extensive tumour. The absence of the tumour can usually be demonstrated by palpation. Again M.Rehfuss,M.D.,(28) had a case in which the X Ray ex-

hibited a typical picture of annular carcinoma. The growth appeared to be sharply confined to the pylorus. Four weeks later the patient was re-examined and the picture remained the same. Three years later the patient was again examined and the stomach found to be normal. In this case all the other evidence except that of the X Ray was negative.

Wrong Negative Diagnosis.

Carcinoma may be present in the stomach without the X Ray being able to reveal its presence.

L.R. Broster, O.B.E., M.D., F.R.C.S., (29) had four cases in which the radiogram showed no definite deformity, while M. Reh fuss, M.D., (30) had a very interesting case in which a palpable mass was present involving the liver. The stomach was X Rayed from all angles and no defect could be produced. At the operation two small plaques were found in the gastric wall which could only be appreciated by actual palpation of the wall.

H. Maclean, M.D., M.R.C.P., (31) points out that in the early stages of carcinoma near the pylorus, little if any obstruction may be present. The condition is such that a patent tube exists, with a niche from irregular walls. The mobility is practically normal except perhaps for a slight persistent defect.

Cases with Gastric or Duodenal Symptoms
without Organic Disease.

The fallacy in this class of case is chiefly the wrong diagnosis of organic disease where none exists.

L.R. Broster, O.B.E., M.D., F.R.C.S., (32) quotes several cases in which the X Ray diagnosed duodenal lesions and at the operation performed later no lesions were found. The usual condition present was that of chronic appendicitis or Lane's kink. In another of his cases a crater on the lesser curvature was diagnosed, but this was non-existent at the operation.

With regard to the question of stomach mobility, J.A. Ryle., M.D., F.R.C.P., (33) states that the weight of the bismuth employed, constitutes real fallacy in this estimation.

Dangers of Perforation.

The danger of perforation of an ulcer as a result of an X-Ray examination is a point of great importance and must be kept in mind by Radiologists. In many cases the examiner has to palpate the organ so as to outline the rugae of the stomach. Should there be a deep ulcer present, involving the three coats of the stomach, there is always a danger that the peritoneal coat may give way when the bismuth is pushed into it. As the examiner does not know the state of affairs

before the examination, it is essential that great care be taken. It is well recognised that perforation of an ulcer usually takes place after a full meal, this being so, it is always a possibility which must be borne in mind, that an ulcer may perforate even as a result of simply ingesting the ordinary bismuth meal which is necessary for the examination.

SUMMARY OF MY OWN RESULTS.

In my series of twenty eight cases which I investigated and in which X Ray examinations were done, there were seven cases of suspected gastric ulcer, but only three proved to be definitely so, the remainder were not. Of the three cases, the X Ray made a positive diagnosis of ulcer in one. This was a penetrating ulcer of the lesser curvature of the stomach and the size and position of same was correctly diagnosed. The other two cases had had attacks of haematemesis and in both cases the X Ray examination failed to reveal any pathological condition in the stomach. This is significant, in view of the fallacy which arises through the time of X Ray examination in relation to symptoms.

In the remaining four cases, the X Ray made a correct negative diagnosis.

There were twelve cases of suspected duodenal ulcer and a pathological condition was found in seven. One was a case in which internal hemorrhage had taken place. In this case the X Ray was again unable to demonstrate any abnormality other than hypertonicity and ptosis of the stomach; this is significant. In another case, the X Ray showed a positive shadow in the duodenum which was tender,

and the correct diagnosis of chronic duodenal ulcer was made. In the third case, the X Ray report stated that there was a little obstruction at the pylorus. At operation the duodenum was found to be dilated as far as the point where the mesenteric vessels crossed it. The duodenum was also freely movable. This was a case of duodenal ileus.

In the remaining four cases, the X Ray demonstrated irregularity of the duodenal cap. The Radiologist was unable to fill out the cap. He was unable to demonstrate any ulcer crater in any of the four cases. In two of these cases, gall stones were also present and there were adhesions between the duodenum and the surrounding structures. This undoubtedly partly accounted for the difficulty which the Radiologist experienced in trying to fill out the duodenal cap in these two latter cases. In the other five cases the X Ray made a correct negative diagnosis.

There were two cases of carcinoma, and in one the X Ray gave a correct diagnosis, a carcinomatous filling defect being demonstrated. In the second case the radiological report was definitely wrong. It was as follows; "there might be a gastric or even a duodenal ulcer, but there is nothing to suggest carcinoma." At operation a large carcinoma was found to be involving the antrum.

Of the remaining seven cases, in one the X Ray suggested a duodenal lesion, but at operation the stomach and duodenum were found to be quite normal. Another case was very interesting in showing the effect of distention of the large bowel on the stomach. In this case the stomach was very irregular in appearance and the Radiologist suggested that the trouble was due to distention of the large bowel causing pressure on the stomach. At operation the large bowel was found to be twisted and greatly distended.

In three cases which were X Rayed, the reports were as follows; in two the stomach was found to be hypotonic and in the third case normal. At the operations performed later, these reports were found to be correct and appendicitis was found to be present in each case.

In the two remaining cases, the X Ray showed a normal picture of the stomach and duodenum.

The X Ray gave a correct diagnosis in twenty three out of twenty eight cases, which equals 82.1 per cent.

A wrong diagnosis was made in five cases which equals 17.9 per cent.

In the cases of gastric and duodenal ulcer and carcinoma, the X Ray made a correct positive diagnosis in eight out of twelve cases, which equals 66.6 per cent.

In four of the twelve cases, the X Ray made a wrong negative diagnosis, which equals 33.3 per cent.

Of the sixteen remaining cases, the X Ray made a correct negative diagnosis in fifteen, which equals 93.1 per cent, and one wrong positive diagnosis which equals 6.9 per cent.

DISCUSSION.

The percentage of correct results which my cases give in favour of X Ray are slightly lower than those given by expert Radiologists.

G.H.Orton,M.D.,D.M.R.E.,(34) considers that the X Ray gives correct results in over ninety six per cent of cases, while M.Haudek,M.D.,(35) states that if we are to believe the X Ray can detect an early lesion (carcinoma), then if the X Ray says there is no lesion it is reasonable to suppose that this is so.

Despite the opinion of these experts we must realize that even now, X Ray is not by any means infallible. The results depend on so many things; apart altogether from fallacies which I have mentioned previously, there are five points which have a great bearing on the result of every X Ray examination.

These are as follows:-

1. The radiologist.
2. The method and technique of examination.
3. The preparation of the patient.
4. The type of patient.
5. The age, history and complaint.

I shall consider all these points in detail.

1. The Radiologist.

M.Haudek, M.D., (36) considers that the result of an X Ray examination depends chiefly on the skill and experience of the examiner. He should be acquainted with the history and results of the clinical investigation and so have a good idea before the examination, for what he is looking. It is obvious that more weight can be attached to the opinion of a skilled Radiologist who knows the case, than to that of a man of practically no experience, who simply sees the patient, carries out the examination and has no knowledge of the patient's symptoms or history.

2. The method and technique of examination.

- (a) Did the Radiologist examine the stomach and duodenum with the first mouthful of bismuth? If he did not, then there is the possibility of a lesion being missed. M.Haudek, M.D., (37) shows this very clearly.
- (b) Did the Radiologist carefully palpate the organs and outline the stomach and duodenum, so as to outline the rugae and get a good view of the duodenal cap?
- (c) Did the Radiologist examine the stomach in the right oblique plane so as to view the posterior wall?
- (d) Did the Radiologist carry out the examination in the erect and supine position? If not, then

it is impossible to examine both curvatures and if this is not done, a lesion may be missed.

If the answers to the above questions are all in the affirmative, the examination has been carefully and thoroughly performed and so more notice can be taken of the diagnosis made, than if there were any negative answers.

3. The preparation of the patient.

If the patient has been allowed food a short time before the examination and the Radiologist is in ignorance of this fact, then he may diagnose a pathological condition, whereas the picture given would be due to the food residue. H. Maclean, M.D., M.R.C.P., (38) points out, that if the patient be severely purged before the examination, this may give rise to increased peristalsis of the stomach with consequent hurry of the contents and so the suspicion of a duodenal lesion might be raised. Careful preparation of the patient to make sure the stomach is empty, without undue purging is very important.

4. The type of patient.

If the patient be an obese subject, or be very muscular with strong abdominal muscles, the difficulty of outlining the rugae by palpation would be very great. As it is only by outlining the rugae that ulcers which only involve the mucous membrane can be definitely

diagnosed, it follows that in these cases if ulceration is suspected and the X Ray examination is negative, then little or no weight can be attached to it. In thin subjects, on the other hand, the examination is much more easily performed and a negative diagnosis in such cases would be of more value.

5. The age, history and complaint.

The patient's age is of a certain amount of importance in cases of suspected carcinoma. The history is of great importance for two reasons:-

(i) It is obvious that if a patient has a long history suggestive of ulceration, there is more likelihood of a definite crater or niche being present, than if the patient's history is only of a few weeks duration.

(ii) The second point is that a long history is more in the favour of ulceration than of growth, although one must always remember in cases of gastric ulcer, that there is always the possibility of malignant changes taking place.

The suspected complaint is of importance so that the Radiologist may have some idea of where the trouble is likely to be found. For instance, in cases of duodenal ulcer, there is usually great difficulty in demonstrating the crater and so the Radiologist can concentrate on the duodenum, after he has excluded any

pathological condition in the stomach.

In cases of stomach ulceration in which there is a definite crater the X Ray seldom, if ever, fails to reveal its presence if a careful examination is done. The chief difficulty arises in finding small ulcers which only involve the mucous membrane. As I have pointed out, these can only be exposed by careful palpation and unless the subject is suitable, that is, neither too fat nor too muscular, the difficulty of doing so is very great and this point must always be borne in mind by the Physician when accepting the X Ray diagnosis.

Ulcers of the stomach situated in the neighbourhood of the pylorus offer most difficulty, from the point of view of an absolutely positive diagnosis.

There are two main reasons for this. First of all because the ulceration may not produce any deformity, and secondly the difficulty of diagnosing the ulcer in this neighbourhood from early carcinoma. In connection with the latter reason, the X Ray will in all probability diagnose a pathological condition, which is very important, but may be quite unable to determine whether the condition is simple or malignant.

With regard to ulceration of the duodenum, there is more difficulty experienced than in cases of ulceration of the stomach. First of all there is great

difficulty of demonstrating an ulcer niche, owing to the fact that the whole organ is more liable to be affected by a spasm. Secondly, adhesions between the duodenum and the surrounding structures, for example the gall bladder and the Liver, cause deformity of the duodenal cap and render the Radiologist's efforts to fill it completely, of little or no avail.

Since, before the Radiologist can make an absolutely positive diagnosis of the presence of an ulcer, it is imperative for him to be able to demonstrate a crater no matter how shallow it may be, if he is unable to do so, then an absolutely definite diagnosis cannot be made.

In my own results, out of six cases of duodenal ulcer, the crater was only demonstrated in one. In four, deformity of the duodenal cap was found and the suggested diagnosis of duodenal ulcer was correct. In two, cholecystitis with adhesions between the duodenum and gall bladder was present, so that the X Ray picture was confused. The chief point to note is that the X Ray did reveal a pathological condition in all four of these cases.

With regard to the question of carcinoma, we must be very careful before accepting a negative result of an X Ray examination. In any case in which carcinoma is suspected and in which the X Ray gives a

negative report, the X Ray must be ignored or a second examination performed.

Many of the fallacies which I have quoted in the foregoing pages, demonstrate the fact that the X Ray cannot always be relied upon to show the presence of carcinoma, especially in its early stages. A case which M.Rehfuss,M.D.,(see page 12) quoted is significant. In this case he pointed out that it was quite impossible to tell that any changes had taken place, without actually palpating the wall of the stomach. In one of my cases, the X Ray examination failed to make any suggestion of carcinoma and yet a large carcinoma was found at operation. Further, a carcinoma may be present in the stomach without producing any obstruction and little, if any, deformity.

In cases where there is hour glass contraction of the stomach, it is quite impossible to tell by X Ray whether or not the deformity is due to carcinoma, or a saddle shaped ulcer. Furthermore, as M.Haudek,M.D., (39) points out, there are four other causes which may produce a picture similar to that of carcinoma. These I have enumerated previously.

Dr. A.Charles, Superintendent of the Cancer Hospital in Dublin, has been carrying out treatment of duodenal ulcers by deep therapy.

I have seen a patient who had the history of

twenty years standing , and during the last ten years has never had any more than three months freedom from pain. This patient was treated in July 1929 and in February 1930 he was absolutely clear of symptoms, I mention this point, as it shows the great necessity of being able to tell the exact position of the lesion, as unless this is known the treatment cannot be given.

In cholecystitis there may be adhesions between the gall bladder and duodenum and this will produce deformity of the duodenal cap. Gall stones, of course can now be demonstrated by injecting the patient with Tetra Iodophenolthelein and X Raying the gall bladder afterwards. Reflex irritation of cholecystitis does not produce any definite or uniform changes in the stomach, which the X Ray can demonstrate.

In cases of chronic appendicitis with symptoms which seem to be referable to the stomach, X Ray of the stomach does not give any help. The reports vary; the condition of the stomach may be hypotonic or normal; no definite changes seem to take place as the result of any reflex irritation. If, however, the appendix itself is examined then a pathological condition may be found therein.

To sum up, one may state that if the result of the X Ray examination agrees with the history and the

results of clinical investigation, it is almost certain to be correct, and will in all probability give very valuable information with regard to the extent of the lesion, and any deformity which may be resulting from its presence. Regarding the latter point, we must always remember that the condition may be exaggerated.

In cases where the X Ray makes a positive diagnosis of unsuspected disease in the stomach or duodenum, that is, if there is nothing in the history or clinical investigation to support the X Ray diagnosis, then the result of the examination should either be ignored or else the examination should be done again.

Whenever the X Ray makes a definite negative diagnosis and the history and clinical investigation are strongly in favour of the presence of some organic trouble, then the result of the clinical examination and history should be accepted before that of the radiological examination.

Radiology is an excellent servant to the Physician but a very bad master.

THE VALUE OF TEST MEALS.

The two commonest used meals of the present day are:

- (1) Ewald's one hour tea and toast meal.
- (2) Fractional test meal of M. Rehfuss, M.D., (40),

Ewald's Test Meal.

In this method the patient having fasted from the night before is given one pint of tea and an ounce of toast usually at 9 a.m.

One hour afterwards the gastric tube is passed and as much fluid as possible is withdrawn from the stomach. The material withdrawn in this manner is examined:-

- (1) Macroscopically.
- (2) Microscopically.
- (3) Chemically.

As the result of the macroscopic examination the following points are noted:-

- (i) The amount recovered.
- (ii) The odour and colour, presence or absence of solid particles of food taken the day before, excessive amounts of mucus.

From the microscopic examination, presence of

unaltered food, starch granules, torulae, sarcinae, epithelial cells, and Boas-Oppler bacilli is noted.

From the chemical examination is found the presence or absence of free and combined hydrochloric acid, lactic acid and other organic acids.

FRACTIONAL TEST MEAL.

In this method, overnight, the patient is usually given a light supper, consisting of a glass of milk and a charcoal biscuit. Next morning a tube for example that of J. A. Ryle's, M.D., F.R.C.P, (41), is swallowed by the patient. The tube is measured so that when a certain mark is reached, in practically every case, the situation of the lower end of the tube is in the fundus of the stomach. The operator then removes all the fasting contents of the stomach (if less than twenty c.cs. is recovered then the probability is that the stomach has not been completely emptied). When the stomach is emptied, the patient is given a gruel meal, which is prepared as follows:- One ounce of fine breakfast oatmeal is mixed in a quart of water and boiled until the total bulk is reduced to one pint. This is then strained through muslin, and if necessary flavoured with salt. Every fifteen minutes after the meal has been swallowed, the operator removes 10 to 15 c.cs. of fluid

from the stomach with the aid of a syringe. The syringe is then emptied after each aspiration into test tubes which are marked according to times. From 8 to 12 specimens are withdrawn. During the period the test is being carried out, the patient is encouraged to read or occupy his mind in some manner. The specimens are examined macroscopically and chemically and if necessary microscopically. The presence or absence of mucus, bile, blood, and starch is noted. Special note is made of the amount of the fasting contents and the presence or absence of a foul odour, charcoal and food. Every one of the specimens are also examined for the presence of free and combined hydrochloric acid and their percentages plotted in a graph specially designed for the purpose.

H. Maclean, M.D., M.R.C.P., (42) lays special stress on the examination of the specimens for the presence of lactic acid in cases of suspected carcinoma.

With Ewald's meal the result given is inconclusive, no matter how thorough the examination.

G. E. Beaumont, M.D., F.R.C.P., and E. C. Dodds, M.V.O., M.D., (43) give the following four factors which vary even in a normal individual and which appear to have an influence on the composition of

the specimens of gastric contents removed.

These are as follows:-

- (1) The volume and nature of fluids in the stomach at the time of giving of the meal.
- (2) The volume and nature of the meal.
- (3) The rate and amount of gastric and salivary secretion.
- (4) The condition of the pylorus with regard to
 - (a) The passage of fluid from stomach to duodenum.
 - (b) The regurgitation of fluid from the duodenum to the stomach.

These factors have a very great influence in rendering the one hour test meal extremely unreliable. As these authors point out Ewald laid great stress upon the volume of the gastric contents recovered after his meal. As the volume recovered would vary in amount, according to whether or not the stomach was empty or otherwise at the time of giving the meal, it ceases to have any great importance.

With regard to the volume and nature of the meal, this in a case of the fractional method is more or less standardised. The Ewald meal does not take any note of the rate and amount of secretion, whereas the fractional method through taking the fasting contents as well as the specimens every 15 minutes up to three hours after the meal has been ingested, covers any

fallacy which is liable to occur with regard to this point. The salivary secretion does have a certain effect in altering the acidity of the fasting contents owing to the fact of some being swallowed with the tube, but for the remaining specimens the salivary secretion has no effect as it can be eliminated by getting the patient to eject any saliva.

The Ewald meal does not give any or gives very little indication of the state of the pylorus, whereas the fractional method is excellent with regard to giving information on this matter.

M. Rehfuss, M.D. (44), who was the originator of this method, considers that by this examination it is possible to: -

- (1) Estimate the work of the mucous membrane (i.e. by amount of secretion).
- (2) Estimate the efficiency of the gastric wall and the efficacy of the pyloric sphincter (i.e. by disappearance of starch showing the evacuation time).
- (3) Helps to determine pathological conditions (i.e. the presence of blood or excess of mucus).

G. E. Beaumont, M.D., F.R.C.P., and E. C. Dodds, M.V.O., M.D., (45), summarise the usefulness of the fractional method as follows:-

- (1) It enables the Physician to examine the pyloric function.
- (2) It assists in the diagnosis of juxta-pyloric ulcers and obstruction.
- (3) Assists in the diagnosis of carcinoma and helps in the investigation of cases of achlorhydria.

The Advantages of the Fractional Method.

1. S. Wyard, M.D., M.R.C.P., (46) considers it gives the emptying time of the stomach and M. Rehfuss, M.D., (47) states it is the most accurate method of determining the emptying time in the stomach.

2. J.A. Ryle, M.D., F.R.C.P., (48) states that it permits of accurate measurement of the fasting juice and the state of its mucus, bile and cell content together with the estimation of its free and total acidity. Also it gives in graph form an indication of the chemical process at each stage of gastric digestion, demonstrating such phenomenon as continued secretion; again by regarding the times at which bile regurgitation occurs it gives an indication of the correctness of pyloric relaxation and duodenal reflex. Further, by combining chloride estimation with that of the free and total amount of hydrochloric acid. it

furnishes information relative to the factors causing neutralisation and so indirectly again to the functions of the pylorus.

3. A. F. Hurst, M.A., M.D., F.R.C.P., (49) points out that it affords the only means of recognising gastritis, which he states "is a common disorder formerly diagnosed on incomplete evidence and to-day diagnosed with insufficient confidence".

4. In cases of achlorhydria, T Izod Bennett, M.D., (50) considers that it helps to determine whether the cause is carcinomatous or not.

5. A. J. Walton, M.S., F.R.C.S., (51) holds that in carcinoma the acidity is not only low but that there is complete absence of free hydrochloric acid throughout the whole period of digestion and he points out that it is the latter information which is important and is not given by the Ewald one hour test meal.

6. T. Izod Bennett, M.D., (52) points out that it enables us to find out if there is any hypersecretion and L. R. Broster, O.B.E., M.D., F.R.C.S., (53) that it gives a guide to treatment.

7. The type of curve produced is sometimes an aid to diagnosis and T. Izod Bennet, M.D., (54) considers that the climbing acid curve with pain after food is most likely due to pyloro spasm, and the commonest cause of this condition is peptic ulcer.

8. H. Maclean, M.D., M.R.C.P., (55) considers that the fractional test meal, if the examination is also done for lactic acid, will greatly assist in the diagnosis of carcinoma immediately gastric symptoms arise.

The Difficulties and Fallacies.

The difficulties are only two in number:-

- (1) That of swallowing the tube. This is chiefly found in nervous patients and can usually be overcome by assuring the patient. The best method of so doing is to swallow another tube in front of them. If the tip of the tube is lubricated with glycerine, it usually goes down quite easily. When the point of tube has passed the glottis, the rest is quite easy.
- (2) There may be difficulty of obtaining specimens owing to the blocking of the tube. This can usually be overcome by injecting a little air into the tube.

The fallacies are much more numerous; these are as follows:-

- (1) S. Wyard, M.D., M.R.C.P., (56) points out that the psychic effect which Pavlov demonstrated in his classical experiments on dogs is lost by the simplicity of the meal, but J. A. Ryle, M.D., F.R.C.P., (57) in his work, states that the

importance of psychic secretion is doubtful.

- (2) According to S. Wyard, M.D., M.R.C.P., (58) the rate of emptying of the stomach varies, thus varying the deletion of the gastric juice without altering the total quantity secreted at any given time. The same author states that in many cases the stomach is a vertical tube whose contents are by no means uniform, so that any of the meal removed from the fundus will give a chemical composition different from that removed from the pylorus. In connection with this point, J. A. Ryle, M.D., F.R.C.P., (59) states that the tube is kept at the same level, as it is part of the technique to do so, and E. C. Dodds, M.V.O., M.D., (60) in a paper written by him, states that in cases of hyperacidity where a uniform curve suddenly drops to nothing, it shows that the technique has been at fault and the tube has passed into the duodenum.
- (3) Again, S. Wyard, M.D., M.R.C.P., (61) considers that the chemical reactions, on which the diagnosis depend, are often indefinite and the interpretation of results is involved in so much obscurity that few deductions can be made from them with any definite certainty.

Further, he states that a quantity of saliva is inevitably swallowed with the tube so that, if any acid be present in the stomach, it must be partially or completely neutralised. This he holds is an error which cannot be estimated.

- (4) The tube acting as a foreign body in the stomach is a possible fallacy, but J. A. Ryle, M.D., F.R.C.P., (62) states that inert substances in the stomach do not, apparently, influence its secretory behaviour.
- (5) The stimulation of excessive salivation through the gastric tube acting as a foreign body in the oesophagus is considered by the same authority to be quite definite, and would help to neutralise any free acid, but he points out this can be overcome by insisting on the saliva being expectorated during the meal.
- (6) Emotional inhibition or exaggeration of secretion during the test. T. Izod Bennett, M.D., (63) states that a nervous patient may be so apprehensive that secretion is inhibited and little or no free hydrochloric acid recovered. On a second examination being made and the apprehension moved, free hydrochloric acid is found; this is very important from the point of view of an achylia gastrica, and he thinks that this

condition should not be diagnosed after a single test meal.

- (7) Duodenal regurgitation from retching. This is considered by J. A. Ryle, M.D., F.R.C.P., (64) to be quite definite but he points out that it is very rare.
- (8) H. Maclean, M.D., M.R.C.P., (65) states that the difference between the normal and the pathological is not sufficient in his opinion to render the method of very great value in diagnosis, while M. Rehfuss, M.D., (66) states that a normal gastric physiology is consistent with demonstrable pathology of the organ.
- (9) A. J. Walton, M.S., F.R.C.S., (67) points out that in cases of ulceration which undergo malignant degeneration, a marked diminution of the acidity takes place, but despite this fact, the acidity may still be above normal, so that if there has not been any fractional test meal antecedent to the malignant change then the result of the single test meal would be very misleading.
- (10) G. E. Beaumont, M.D., F.R.C.P., and E. C. Dodds, M.V.O., M.D., (68) consider that the curves are not really secretory curves because they do not represent the amount of free acid secreted owing to the regurgitation of the alkaline duodenal contents.

Variations in Curves from day to day.

J. A. Ryle, M.D., F.R.C.P., (69) states that the variations which take place are very slight and this being so they do not affect the results given by test meal to any great extent.

Summary of my own cases.

Of the forty cases in which I examined fractional test meals, eight were suspected gastric ulcer, twelve suspected duodenal ulcer, two carcinoma, seven chronic appendicitis, two pernicious anaemia, four cases of achlorhydria (three due to gastritis, one to reflex inhibition), five indefinite cases, in two of which the fractional test meal showed hypertonicity with normal acidity, and in the remaining three hyperchlorhydria.

Gastric Ulcer.

Of the eight cases suspected of this disease, three were proved to be definitely so, one by operation, and two because of attacks of haematemesis. In the remaining six cases, the diagnosis was not definitely proved. Of the three positive cases, the fractional test meal suggested duodenal ulcer in one which prove to be a penetrating ulcer of the lesser curvature. The other two test meals showed hyperchlorhydria and delay in emptying, indicating pyloro-

spasm.

In the five cases in which the diagnosis was not proved, in three, the fractional meal showed pyloro spasm, and hyperchlorhydria in the other two.

Duodenal Ulcer.

Of the twelve cases in this group, a pathological condition was definitely diagnosed in seven and not definitely so in five. Of the seven cases, the test meal suggested chronic duodenal ulcer in four, pyloro spasm in two, and was quite indefinite in the last case. Of the five in the second group, the fractional test meal suggested duodenal ulcer in four and was normal in one.

Carcinoma.

In the two cases of carcinoma, the fractional test meal was correct.

Chronic Appendicitis.

The results of the examination in these cases were very varied. Three suggested pyloro spasm, two hyperchlorhydria, one duodenal ulcer, and one was quite indefinite.

Pernicious Anaemia.

As was to be expected, both test meals showed simple achlorhydria.

Gastritis.

In the three cases of this disease, achlorhydria was found to be present. The important point in the test meal results, besides assisting in the diagnosis, was the exclusion of carcinoma.

Indefinite Cases.

There were six cases in this group; two test meals suggested marked hypertonicity of the stomach, three showed hyperchlorhydria (one slight). The last case was one of hypochlorhydria due to reflex inhibition from volvulus of the colon.

Taking the cases in the first three groups in which pathological conditions were definitely proved, the percentages are as follows:- gastric ulcer 66.6 per cent. correct, 33.3 wrong. In the cases of duodenal ulcer 85.6 per cent. correct, 14.28 per cent. erroneous. In the cases of carcinoma, the percentage was 100 correct. The combined percentage in favour of fractional test meal is 84.1 as against 15.87.

In the remaining eleven cases in these groups in which a pathological condition was suspected but not definitely proved, the fractional meal supported the suggested diagnosis in seven, or 63.6 per cent. and gave no definite aid to diagnosis, or was normal in the remaining four or 36.4 per cent.

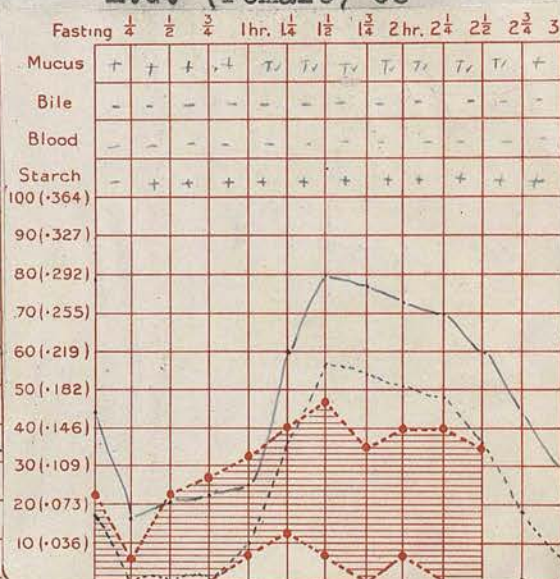
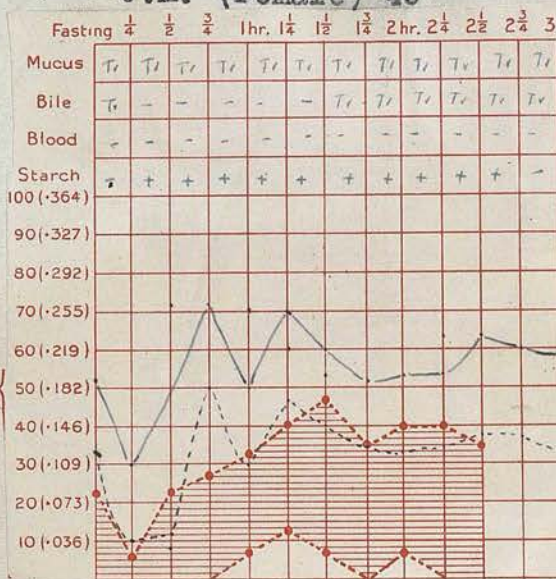
I now append the graphs of the fractional test meals which I performed.

FRACTIONAL TEST MEALS FROM TWO CASES

OF GASTREC ULCER

J.M. (Female) 45

E.G. (Female) 53



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.

----- represents total acidity.

Fasting contents equaled 60 c.cs. Highly acid. Charcoal present also in first and second specimens.

There is delay in emptying, starch being present until the last specimen. This is also proved by the presence of charcoal. The acidity is above normal and there is continued secretion. There is also regurgitation of bile. There is no stenosis of the pylorus as indicated by the regurgitation of bile, and the test meal suggests chronic duodenal ulcer. In this case the X Ray diagnosed ulcer of the lesser curvature which was found to be correct.

Fasting contents equaled 35 c.cs. Acidity high. In this case there is no regurgitation of bile and obvious delay in emptying. The acid curve rises sharply after one hour, then gradually subsides. This examination does not give very definite information.

This fractional test meal was done three weeks after the patient had had an attack of hem

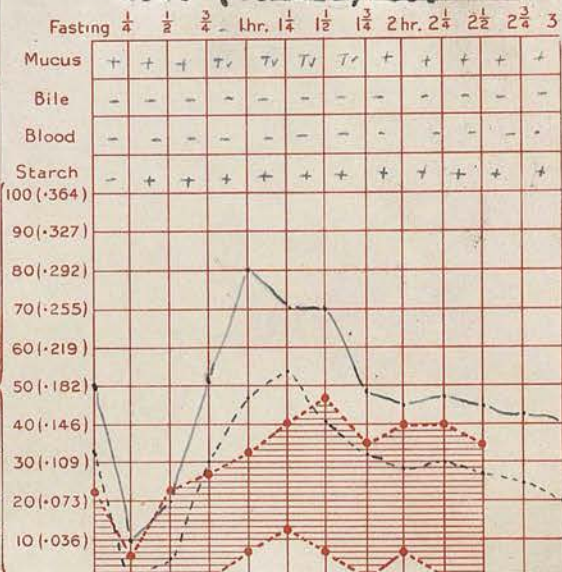
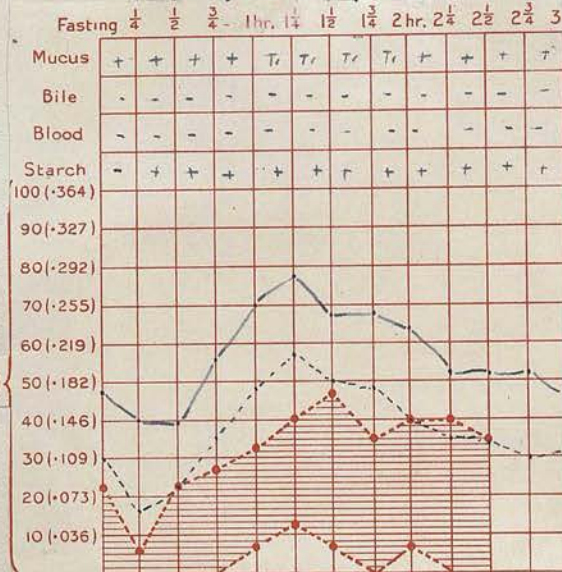
TWO FRACTIONAL TEST MEALS FOR COMPARISON

I. PROVED GASTRIC ULCER.

II. SUSPECTED GASTRIC ULCER.

A.B. (Female) 49.

W.F. (Female) 39.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2 1/2 hours).

..... represents free HCl.
 ——— represents total acidity.

Fasting contents 20 c.c.s.

Fasting contents 70 c.c.s.

Acidity above normal.

Strongly acid.

Delay in emptying. Acid curve rises sharply and gradually subsides, but still remains rather high. The curve does not suggest any definite condition but presence of starch points to some delay

No bile in any of specimens.

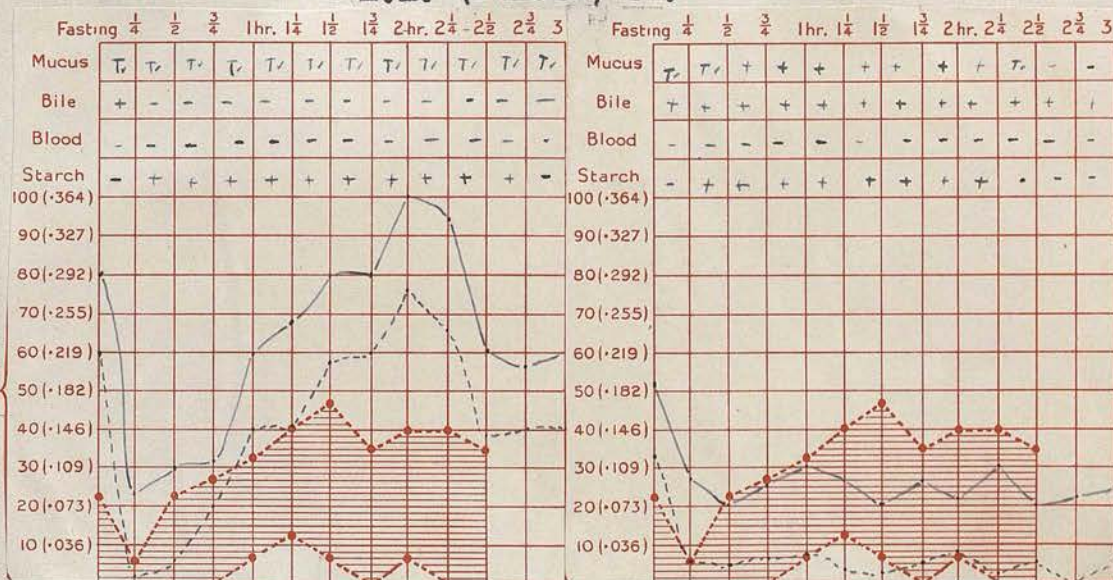
Starch present till the end

The acid curve rises sharply to a point in the fourth specimen and gradually subsides but maintains a fairly high level. Presence of starch indicates delay, but the acid curve is not indicative of any definite condition. Result is suggestive of pylorospasm.

TWO FRACTIONAL TEST MEALS FROM A CASE OF

SUSPECTED GASTRIC ULCER.

E.L. (Female) 17.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.

----- represents total acidity.

Fasting contents 60 c.cs.

Strongly acid, contains bile.

Climbing acid curve and delay in emptying, suggests pyloro spasm

Fasting contents 10 c.cs.

Acidity not so marked.

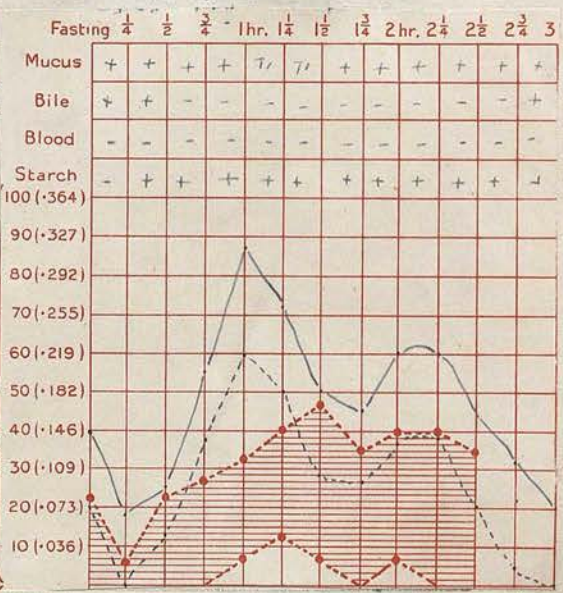
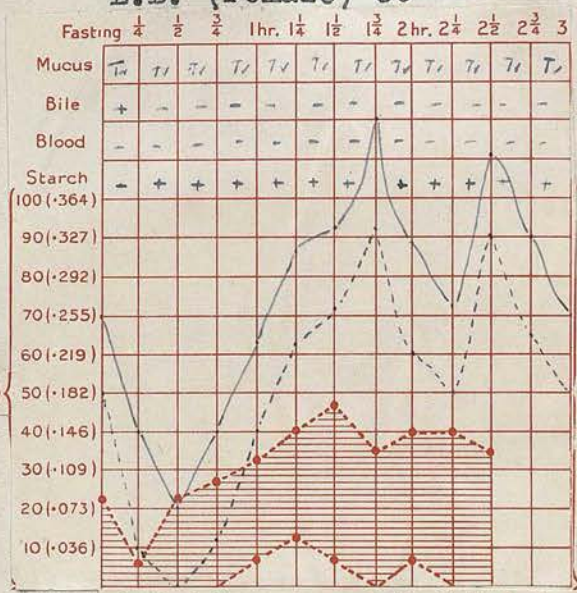
Bile present in all specimens and acidity is definitely lowered, being practically normal.

The spasm of the pylorus has disappeared, indicating improvement as a result of treatment.

FRACTIONAL TEST MEALS FROM TWO CASES OF
SUSPECTED GASTRIC ULCER.

E.B. (Female) 36

A.R. (Female) 54.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2 1/2 hours).

..... represents free HCl.
----- represents total acidity.

Fasting contents 40 c.cs.

Fasting contents 10 c.cs.

Markedly acid and contains bile.

Acidity slightly above normal.

Starch present till end.

Bile in first two specimens and in last.

Noticable delay.
Climbing curve and delay very suggestive of pylorus spasm, so supporting suspected diagnosis of justa-pyloric ulcer.

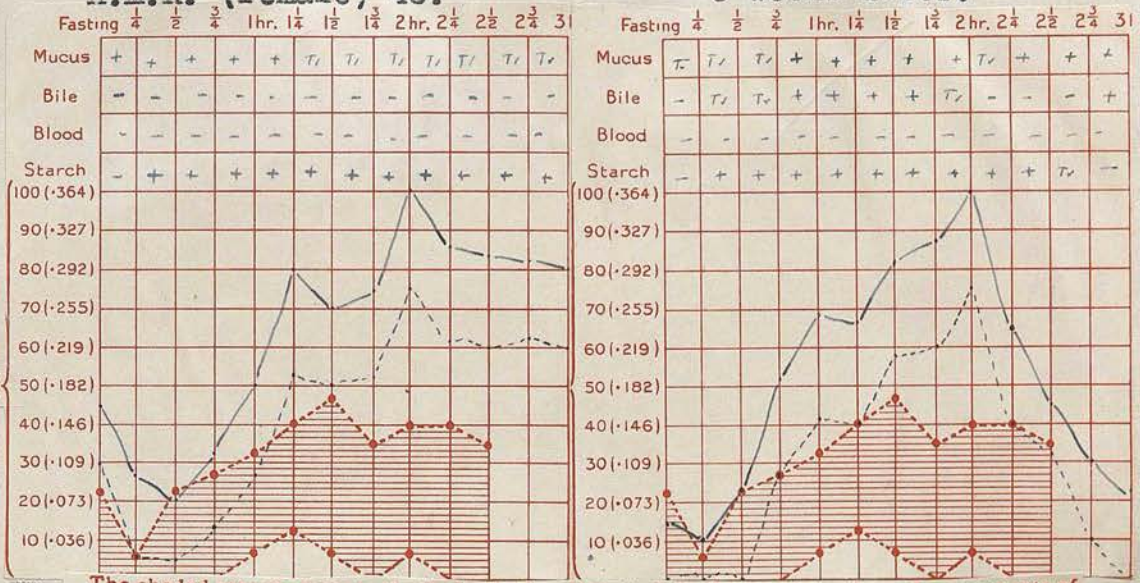
Starch present until end.

Acid curve rises sharply in first four specimens and drops again, but still remains slightly above normal. The presence of starch points to delay. The acid curve is not indicative of any definite condition.
Case of hyperchlorhydria.

TWO FRACTIONAL TEST MEALS FROM A CASE OF
SUSPECTED GASTRIC ULCER

A.M.R. (Female) 48.

3 weeks later.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2 1/2 hours).

..... represents free HCl.
- - - - - represents total acidity.

Fasting contents 60 c.cs.

Fasting contents 10 c.cs.

Acidity above normal.

Acidity reduced.

No bile.

Bile present from second to eighth specimens and in twelfth specimen.

Starch present till the end indicated delay.

Climbing acid curve with acidity maintained and delay in evacuation indicates pyloro spasm and suggests juxta-pyloric ulcer

Acidity rises to a point despite presence of bile and with disappearance of bile, acidity drops. This is the reverse of what usually happens. The acidity is still marked despite treatment.

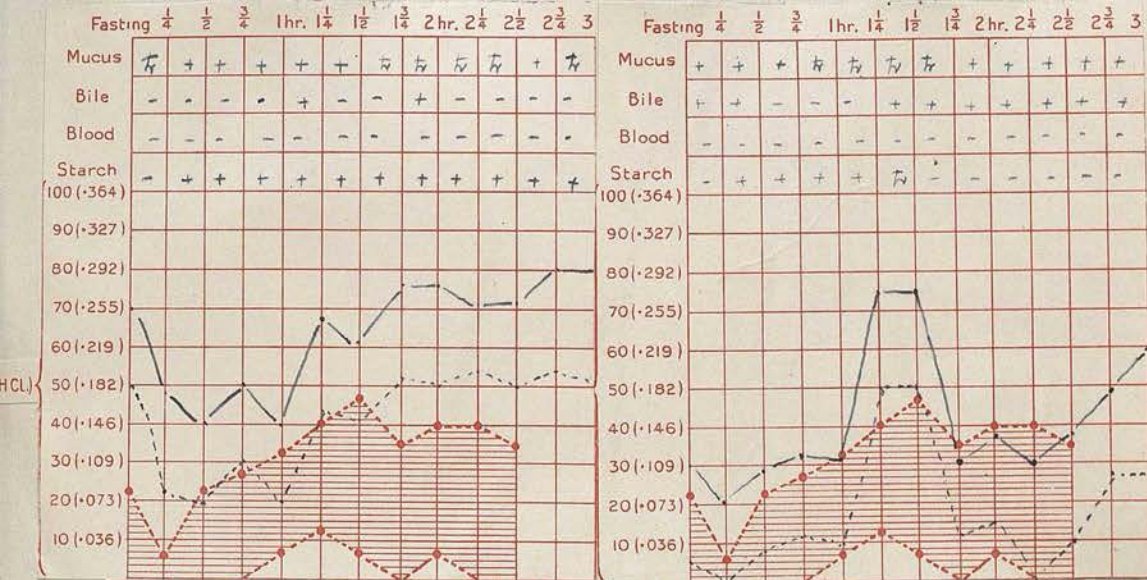
TWO FRACTIONAL TEST MEALS FROM A CASE OF

DUODENAL ULCER

G.W. (Male) 47.

Before Operation.

16 days after Operation.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2 1/2 hours).

..... represents free HCl.

..... represents total acidity.

Fasting contents 80 c.c.s.
 Strongly acid.
 Bile present in the fifth and eighth specimens.
 Starch present until the twelfth specimen indicating delay.
 After ingestion of the meal the acidity drops, but is still above normal and gradually rises and maintains the same level until the last specimen. The shape of the curve and the delay in emptying is very suggestive of chronic duodenal ulcer. This is verified at operation.

Fasting contents a few c.c.s.
 Acidity much reduced.
 Bile present in the first two specimens and in the last seven specimens.
 Stomach empty in one and a half hours. The acidity is about normal until the fifth specimen, after which it rises sharply to a peak and drops sharply after the seventh, and remains within normal limits until the tenth specimen, after which the acidity again rises. The drop in the acidity which followed the sharp rise, coincides with the regurgitation of bile.
 The gastro-enterostomy is seen to be acting quite well by the disappearance of the meal in one and a half hours.

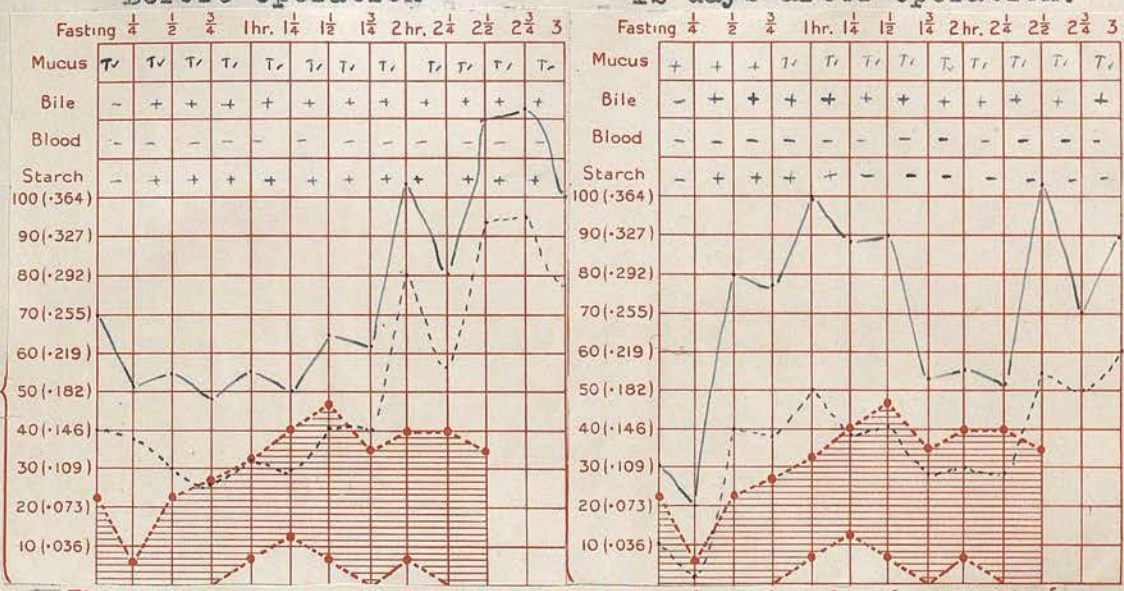
TWO FRACTIONAL TEST MEALS FROM A CASE OF

CHRONIC PYLORIC ULCER.

R.A. (Male) 67.

Before Operation

12 days after Operation.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2 1/2 hours).

..... represents free HCl.
 ——— represents total acidity.

Fasting contents 70 c.c.s.

Strongly acid.

No foul odour.

Bile present in every specimen except the first. Acid level is high and after the seventh specimen rises in a climbing curve until the eleventh, after which there is a slight drop. Starch is present until the twelfth specimen indicating delay. From the presence of bile, there is obviously marked patency of the pylorus, and, from the presence of starch there is marked delay of emptying. The climbing curve is suggestive of pylorus spasm. Diagnosis of chronic pyloric ulcer verified at operation.

Fasting contents 18 c.c.s.

Bile is again present in all specimens except the first.

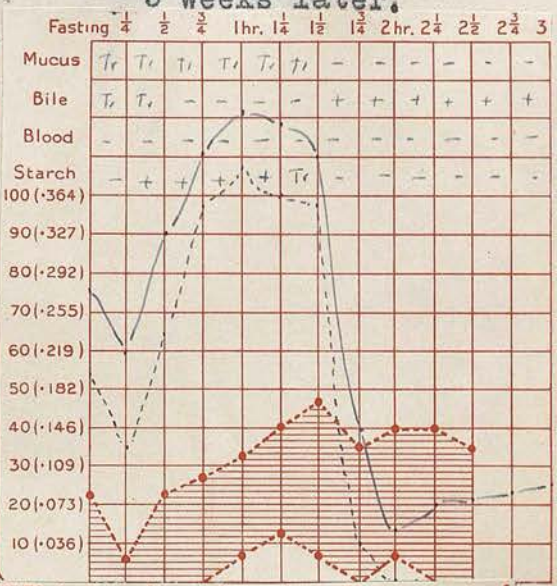
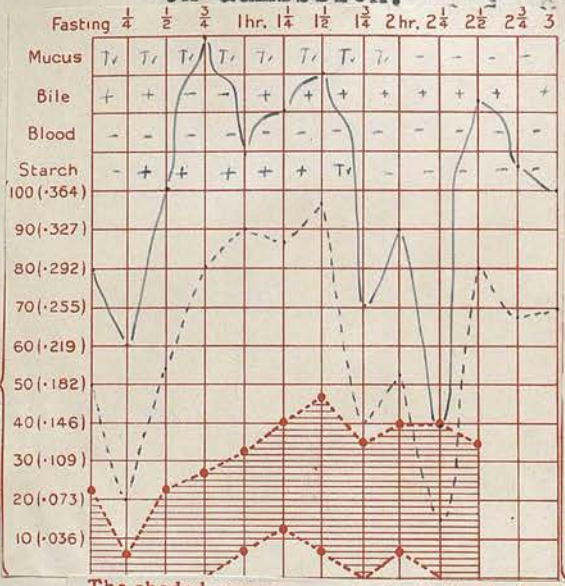
The acidity of the fasting contents is low but after ingestion of the meal, the total acidity rises sharply and is maintained until the seventh specimen when it drops for a short time and rises again sharply to be followed by a slight drop. The free acidity is about the same level as before operation, in the first seven specimens, but is much reduced in the last five. The gastro-enterostomy is seen to be working very well, the meal having left the stomach in one hour

FRACTIONAL TEST MEALS FROM A CASE OF

DUODENAL ULCER.
E.D. (Female) 49.

On admission.

3 weeks later.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2 1/2 hours).

..... represents free HCl.
----- represents total acidity.

Fasting contents 25 c.cs.

Fasting contents 25 c.cs.

Strongly acid.

Was strongly acid and the curve rises sharply after the initial fall which followed the ingestion of the meal.

The meal left the stomach fairly rapidly and the very high acidity is marked from the third specimen, after which there is a fall till the ninth, to be followed by a sharp rise which is maintained. Bile is present throughout the whole meal with the exception of the third and fourth specimens.

The acidity is maintained until bile appears, when there is a marked fall, and then remains low until the end.

From the marked acidity and the presence of bile, the meal suggests some chronic condition of the pylorus or duodenum. There is obviously marked patency of the pylorus. This was a case of internal haemorrhage, so the test meal diagnosis is correct.

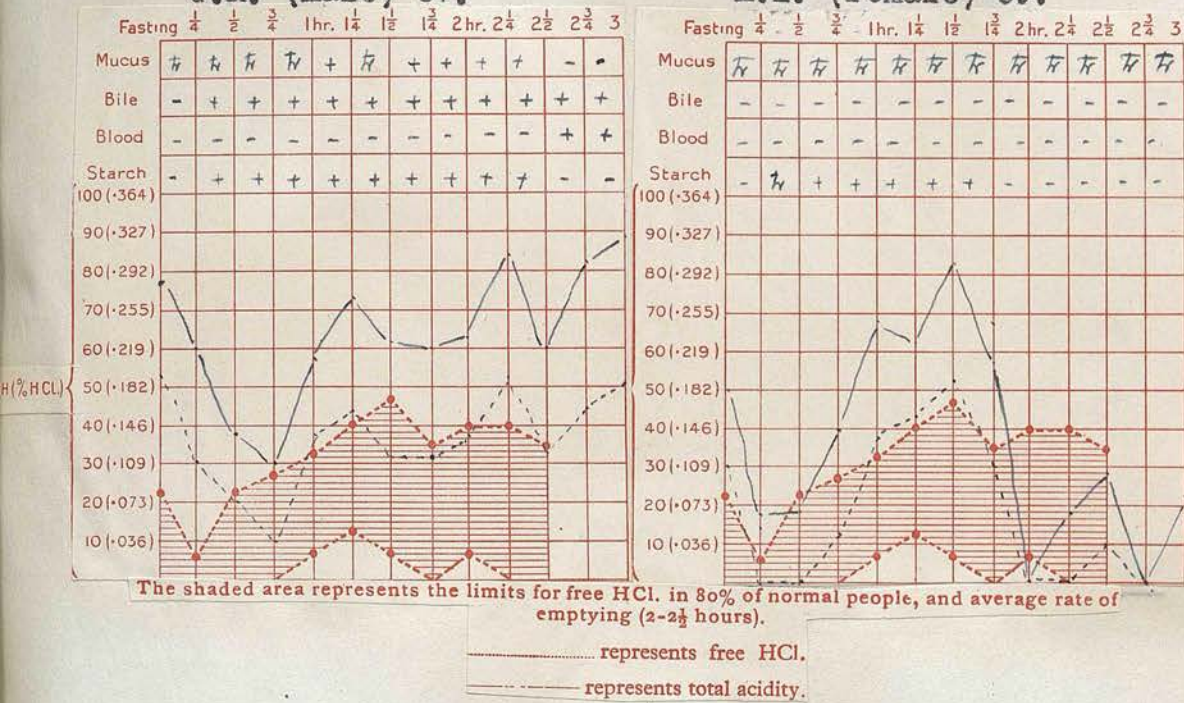
The meal left the stomach at a more rapid rate than previously, but there is a definite improvement in the acidity.

Before this second test meal was done, the patient was entirely free from symptoms.

FRACTIONAL TEST MEALS FROM TWO CASES OFPATHOLOGICAL CONDITION OF DUODENUM

G.R. (Male) 67.

M.L. (Female) 39.

Fasting contents 60 c.cs.

Strongly acid.

No bile.

Bile in all remaining specimens.
 Stomach empty in normal time.
 Acid curve shows initial drop after ingestion and soon after, rises above normal and the rise is maintained to the end. Presence of bile indicates patency of the pylorus. Curve suggests chronic duodenal ulcer. At operation thickening of duodenum was found but no ulcer.

Fasting contents 40 c.cs.

Strongly acid.

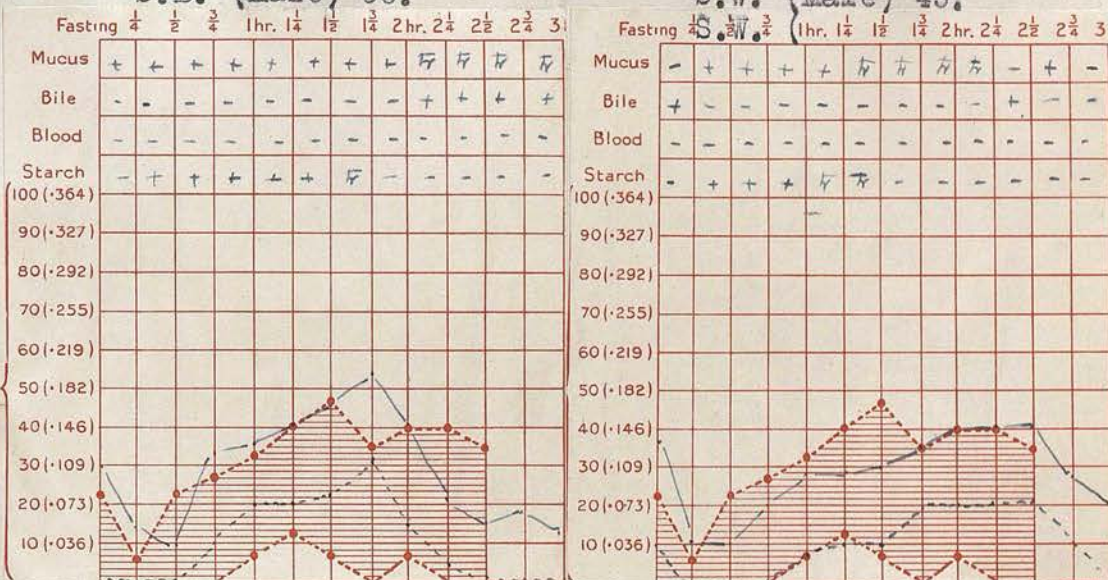
No bile.

Stomach empty under normal time, meal having left under two hours.
 Acid curve rises sharply, but is not maintained on departure of meal.
 Sudden drop shows tube has passed into duodenum. This is due to faulty technique as pointed out by E.C.Dodds, M.D., M.V.O., The test is suggestive of duodenal ulcer but not quite definite. At operation chronic ulcer found.

FRACTIONAL TEST MEALS FROM TWO CASES
DISAGREEING WITH X RAY FINDINGS.

S.B. (Male) 56.

S.W. (Male) 43.



The shaded area represents the limits for free HCl, in 80% of normal people, and average rate of emptying (2-2 $\frac{1}{4}$ hours).

..... represents free HCl.

----- represents total acidity.

Fasting contents 50 c.cs.

Acidity practically normal.

Meal left the stomach under two hours indicating slight hurry.

Bile is present in the last four specimens. The acidity is practically normal, gradually rising to a point in the seventh specimen, after which the acidity drops coinciding with the appearance of bile.

The test meal does not give any definite information, being practically normal.

The X Ray in this case showed a suspicion of irregularity of the duodenal cap.

Fasting contents 20 c.cs.

Acidity slightly above normal.

Meal left the stomach within one and a half hours.

Bile is present in the first and tenth specimens. The acid curve is normal. The X Ray in this case suggested slight obstruction of the pylorus, but the test meal shows that instead of there being any obstruction to the emptying of the stomach, the reverse was the case as the stomach was empty under the normal time of two hours.

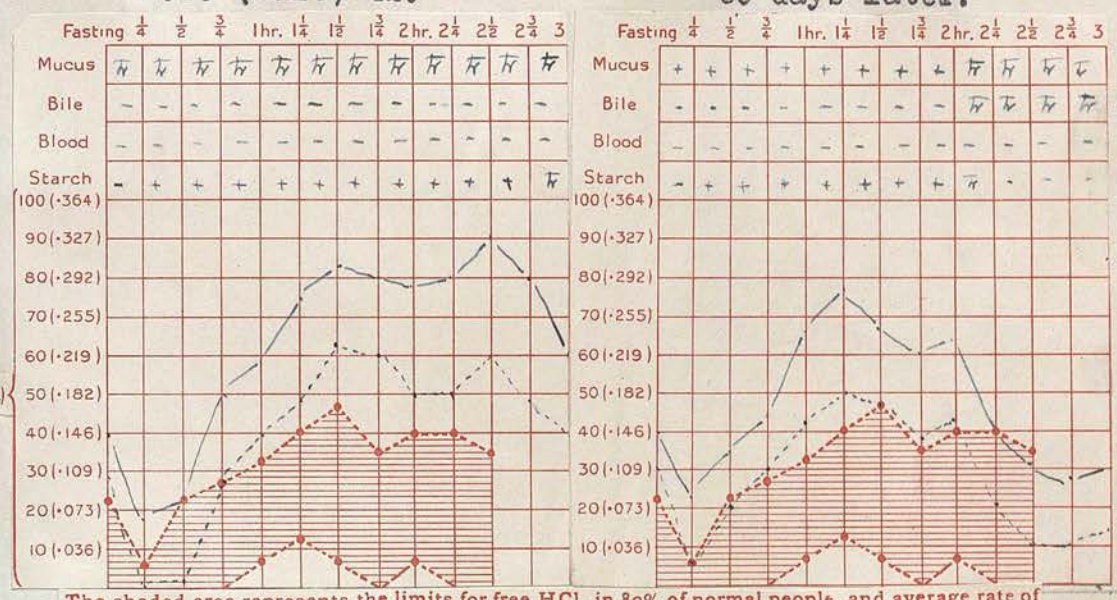
In both these cases the fractional test meal contradicted the X Ray findings.



TWO FRACTIONAL TEST MEALS FROM A CASE OF
SUSPECTED DUODENAL ULCER

H.B. (Male) 42.

30 days later.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2 1/2 hours).

..... represents free HCl.
----- represents total acidity.

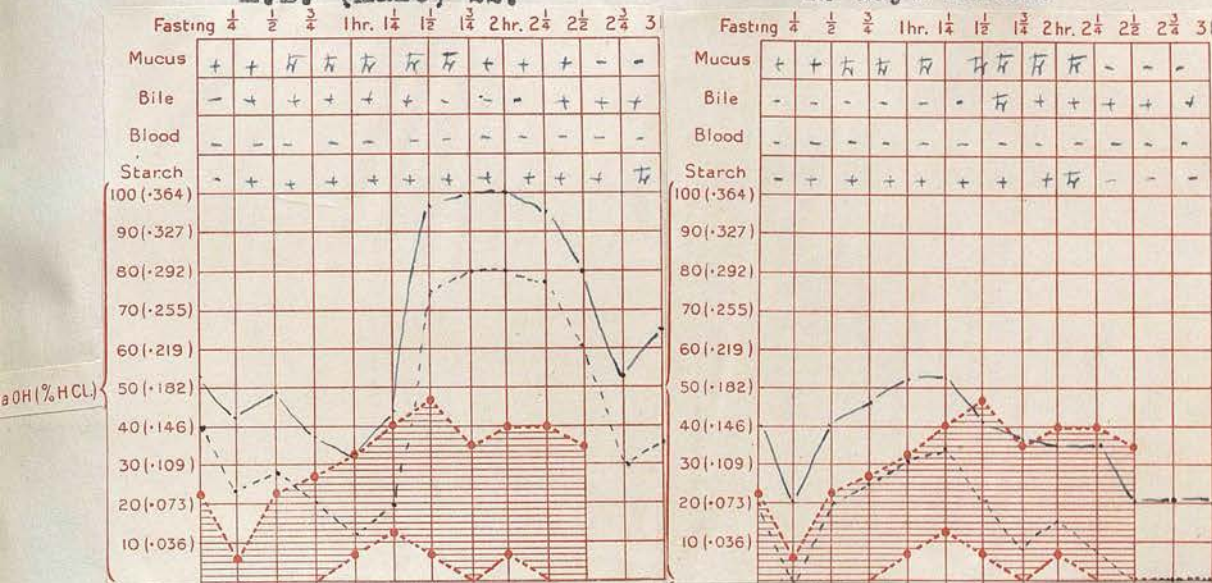
Fasting contents 20 c.cs.
Acid slightly above normal.
No bile regurgitation.
Delay in emptying, starch being present in all specimens.
Acid curve rises rapidly and rise is maintained.
Meal is suggestive of chronic duodenal ulcer

Fasting contents 20 c.cs.
Acid still a little high.
Stomach empty in normal time.
Acidity much improved.
Bile present in last four specimens and acidity drops as a result.
This graph shows the improvement as the result of anti-acid treatment.

TWO FRACTIONAL TEST MEALS FROM A CASE OFSUSPECTED DUODENAL ULCER

E.B. (Male) 22.

12 days later.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.

————— represents total acidity.

Fasting contents 38 c.cs.

Acidity marked.

Bile present from second to sixth specimens and from tenth to twelfth..

The acidity is higher than normal at the beginning and rises sharply with the absence of bile, to fall again to a lower level, though still above normal, on reappearance of bile. There is delay in emptying. Test meal result not very definite, but suggestive of pylorospasm.

Fasting contents 60 c.cs.

Acidity not so marked.

Bile in last six specimens

Stomach empty in normal time.

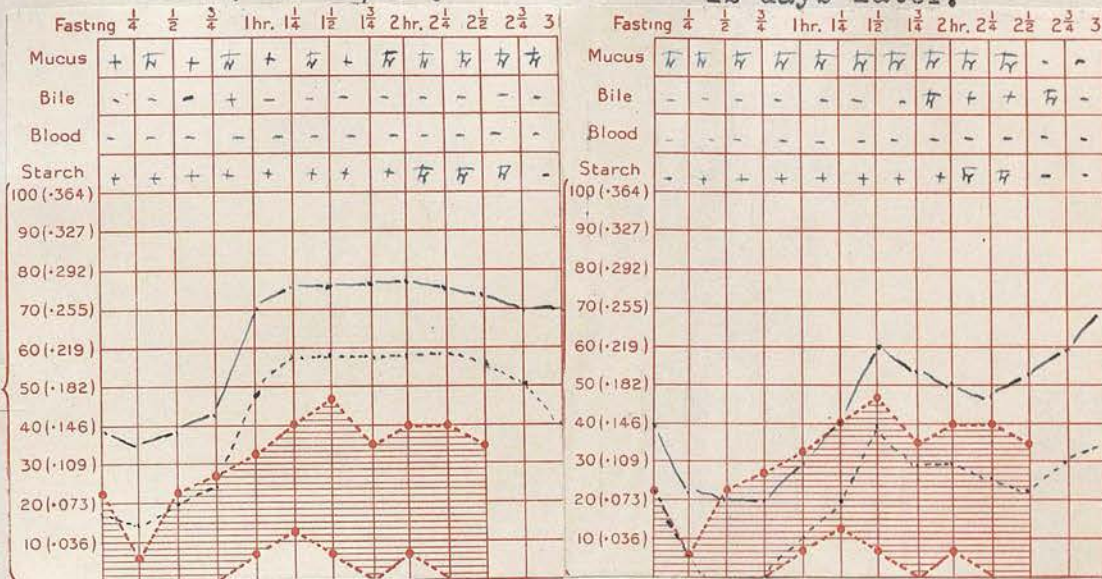
Acid curve practically normal, showing great improvement as the result of treatment.

TWO FRACTIONAL TEST MEALS FROM A CASE OF

SUSPECTED DUODENAL ULCER

E.N. (Female) 57.

12 days later.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.

————— represents total acidity.

Fasting contents 30 c.c.s.

Acidity slightly above normal.

Bile in fourth specimen.

Acid curve rises in fifth specimen and is maintained at high level till end of meal.

Slight delay in emptying. The test is suggestive of duodenal ulcer.

Fasting contents 20 c.c.s.

Acidity still above normal.

Bile present from eighth to eleventh specimens.

Stomach empty in normal time.

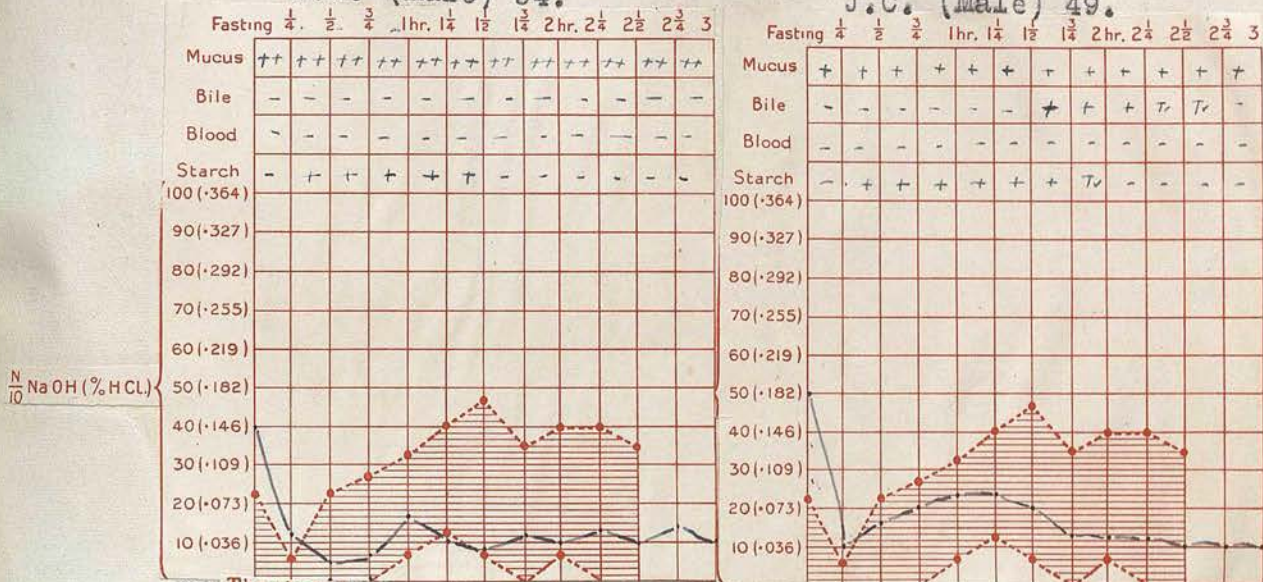
Acid curve not so high as in the previous case. The free hydrochloric acid being within normal limits.

TWO FRACTIONAL TEST MEALS FROM

TWO CASES OF CARCINOMA.

J.F. (Male) 54.

J.C. (Male) 49.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.

———— represents total acidity.

Fasting contents 50 c.cs.

Fasting contents 60 c.cs.

Foul smell.

Slightly foul odour.

Charcoal present.

Charcoal present.

Acidity high.

High acidity.

Remainder of meal shows achlorhydria.

Bile present from seventh to eleventh specimen.

Meal has left stomach under normal time, indicating no delay.

Meal left stomach in normal time

Suggested diagnosis of carcinoma correct.

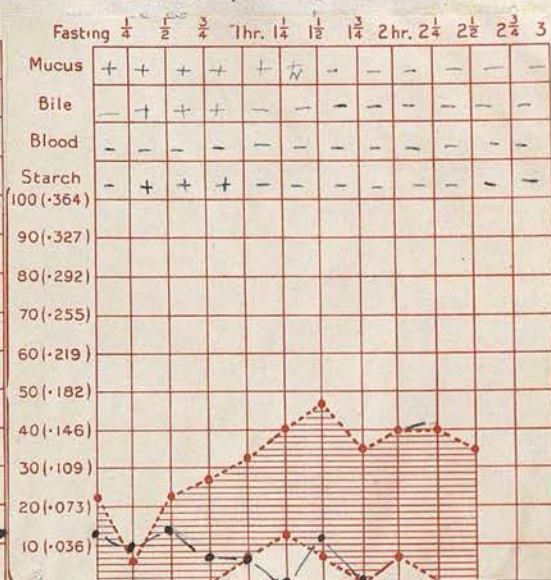
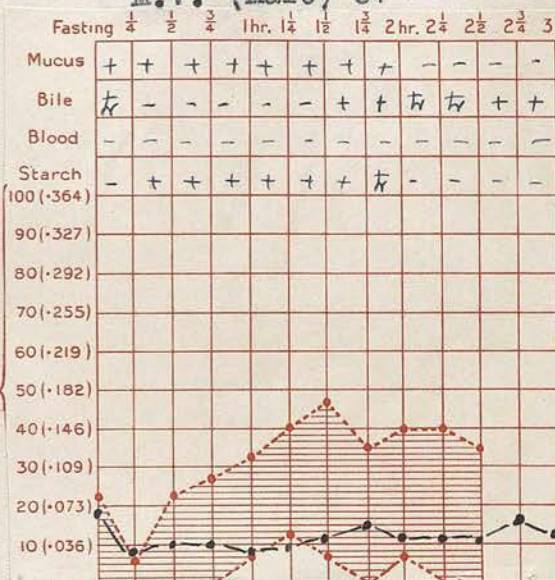
Acidity low.
Suggested diagnosis of carcinoma correct,

FRACTIONAL TEST MEALS FROM TWO CASES OF

PERNICIOUS ANAEMIA.

M.V. (Male) 37

R.P. (Male) 51.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.

----- represents total acidity.

Fasting contents 32 c.cs.

Fasting contents 20 c.cs.

No foul odour.

No foul odour.

Stomach empty in normal time.

Marked hurry of the meal, the stomach being empty within the hour.

Bile present in the first specimen and in the last six.

Bile present in the second and in the fourth specimens.

This is a case of simple achlorhydria. There is nothing to suggest carcinoma.

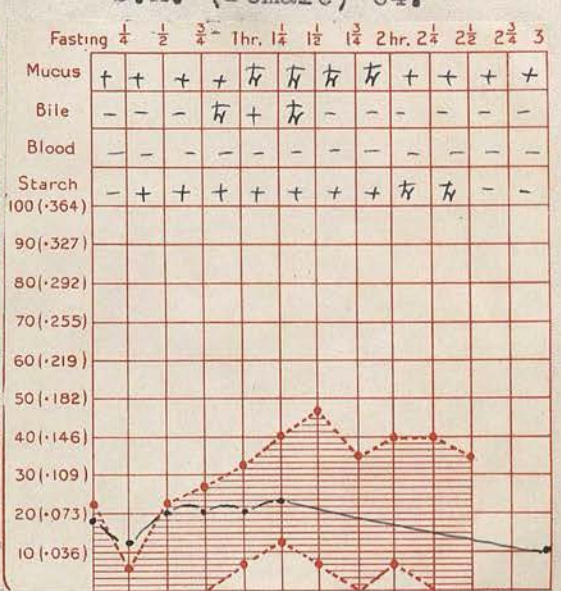
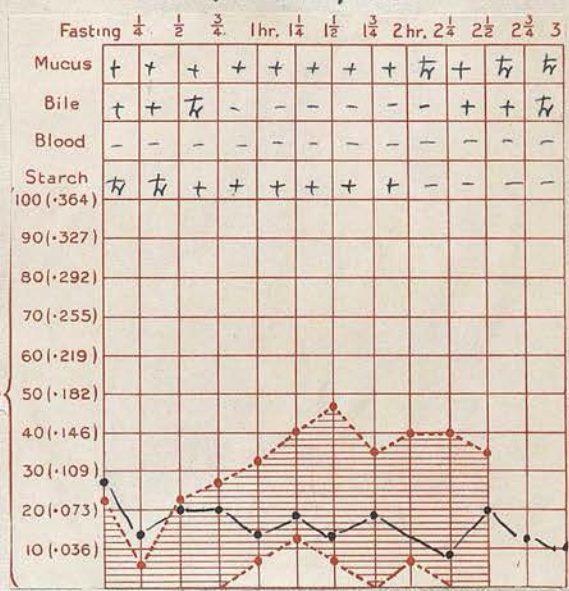
No secretion after one and three quarter hours. Typical case of achylia gastrica.

Nothing to suggest carcinoma.

FRACTIONAL TEST MEALS FROM TWO CASES OF
SIMPLE GASTRITIS.

E.M. (Female) 48

S.H. (Female) 64.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.
- - - - - represents total acidity.

Fasting contents 25 c.cs.

Fasting contents 30 c.cs.

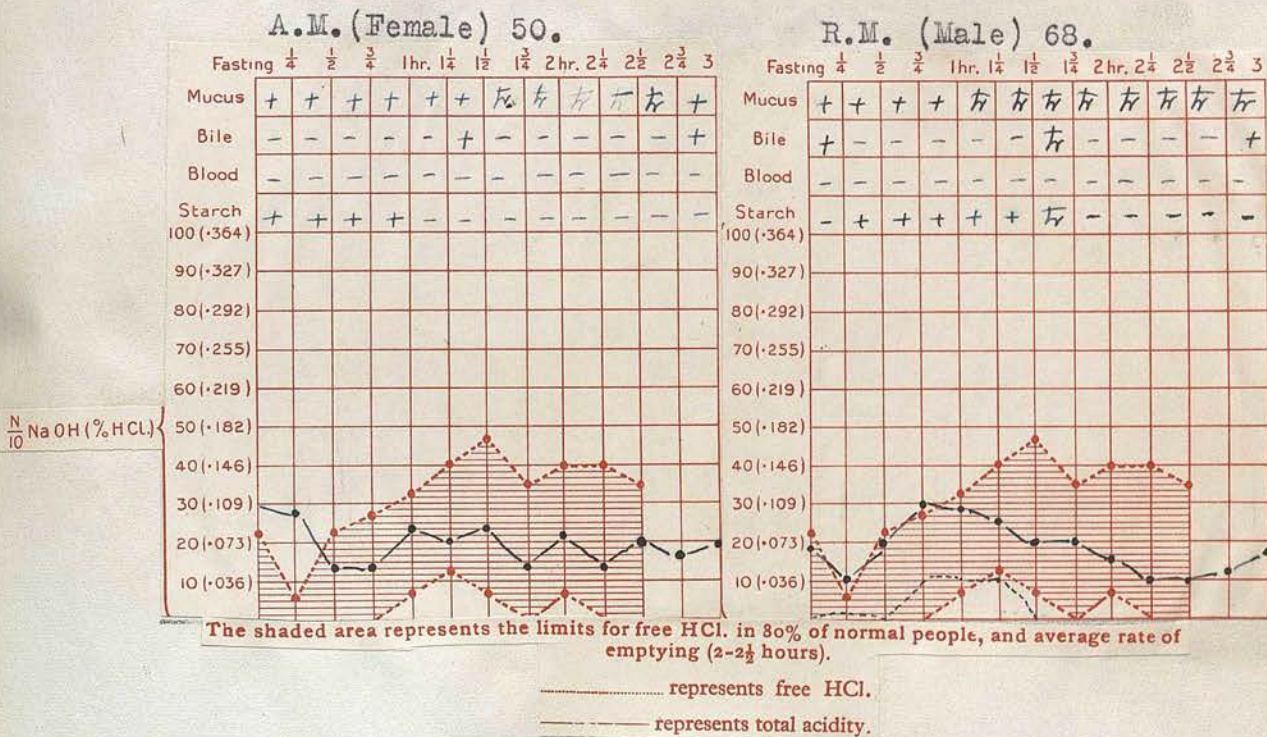
No foul odour and the acidity is not marked.
There is no delay in emptying and there is regurgitation of bile in the first three and in the last three specimens.
No free acid found and nothing to suggest carcinoma.

No foul odour.
Stomach empty in normal time.
Regurgitation of bile present in the fourth fifth and sixth specimens.
No free acid and nothing to suggest carcinoma.
The X Ray in this case suggested duodenal ulcer, which condition is definitely contradicted by the above test meal.

FRACTIONAL TEST MEALS IN TWO CASES FOR COMPARISON

(a) ACHLORHYDRIA

(b) HYPOCHLORHYDRIA



Fasting contents 10 c.cs.

No foul odour.

Acidity slightly above normal.

Marked hurry of the meal as it left the stomach under an hour.

Bile regurgitation sixth to twelfth specimens.

No free hydrochloric acid.

Typical case of benign achylia gastric.

Fasting contents 30 c.cs.

Acidity low.

No foul smell.

Bile present.

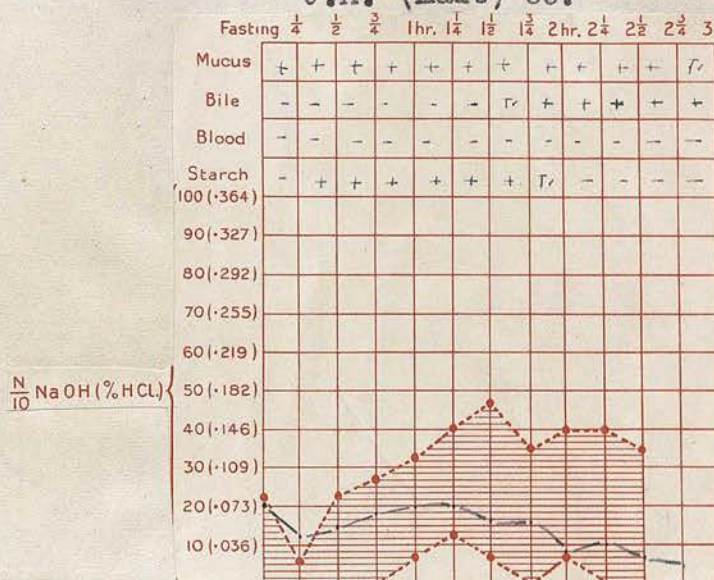
Slight hurry of the meal as it left the stomach under two hours.

There is very little free hydrochloric acid in third, fourth and fifth specimens.

Simple case of hypochlorhydria.

FRACTIONAL TEST MEAL FROM A CASE OFREFLEX ACHLORHYDRIA

J.A. (Male) 33.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.

————— represents total acidity.

Fasting contents 40 c.cs.

Acidity normal.

No foul smell.

Bile regurgitation from seventh specimen onwards.
Meal left stomach normal time.

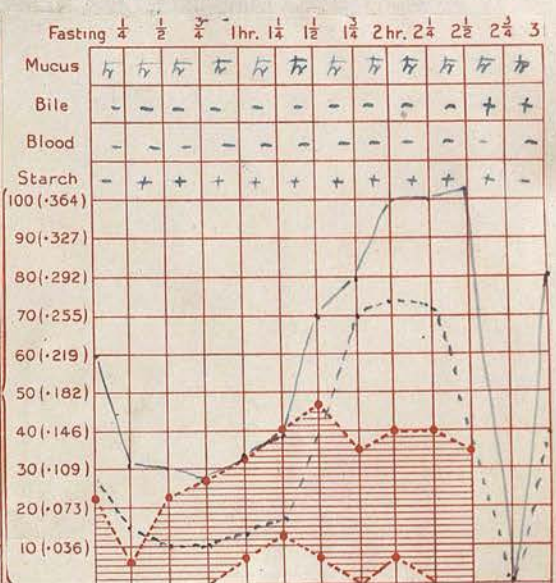
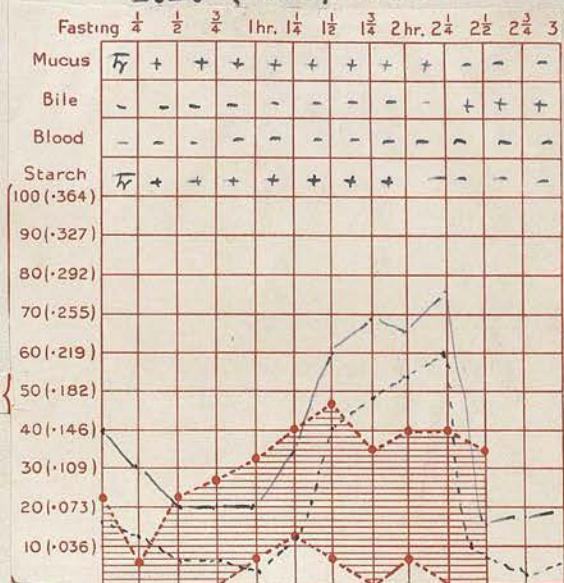
Case of achlorhydria, which in this case was presumably due to reflex inhibition from volvulus of the colon.

FRACTIONAL TEST MEAL IN TWO CASES OF

CHRONIC APPENDICITIS

B.M. (Male) 36.

C.E. (Female) 43.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.

----- represents total acidity.

Fasting contents 45 c.c.s.

No foul odour.

The stomach emptied in normal time, meal having left in two hours. Curve rises sharply after the first hour and subsides at the end of two and a quarter hours. The fall in the acidity coincides with the regurgitation of bile. This curve is simply a case of slight hyperchlorhydria. At operation, chronic appendicitis was found

Fasting contents 60 c.c.s.

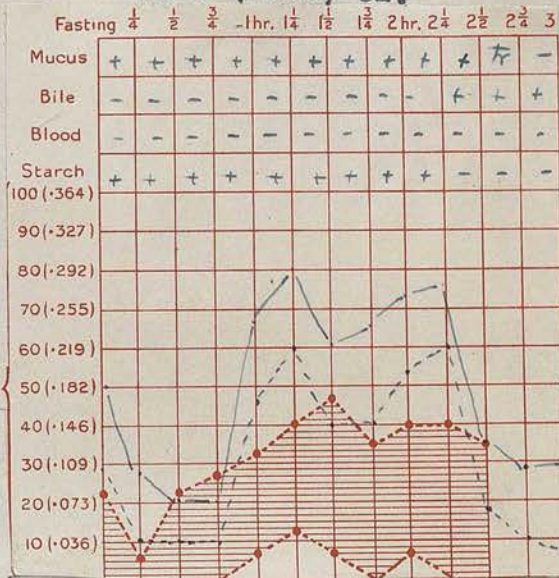
Strongly acid.

No foul odour.

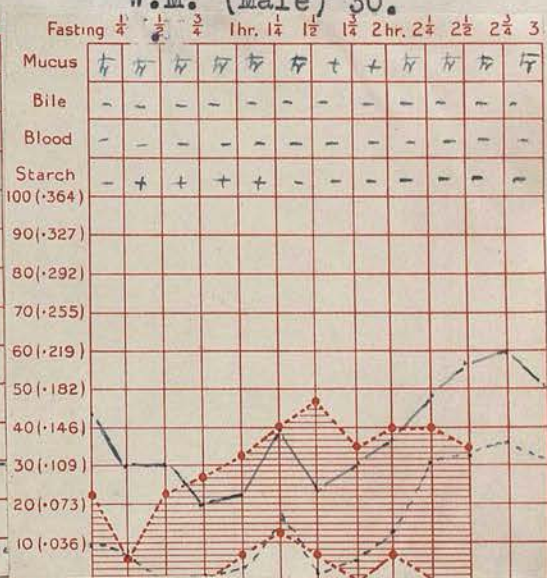
There is slight delay in emptying, starch being present at the end of two and three quarter hours. The acidity is low till one and a quarter hours after ingesting, when it rose rapidly and was maintained until the appearance of bile caused slight reduction. This case also shows the faulty technique of the tube passing into the duodenum. From the climbing curve and sustained acidity, the fractional test meal suggests pylorus spasm. At operation, appendicitis was found.

FRACTIONAL TEST MEAL IN TWO CASES OF
CHRONIC APPENDICITIS

P.P. (Male) 31.



W.M. (Male) 30.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.

----- represents total acidity.

Fasting contents 50 c.cs.

No foul odour.

The meal had left the stomach in normal time, with the disappearance of the meal bile appeared in the specimens. The curve simply indicates hyperchlorhydria.

At operation, chronic appendicitis was found.

Fasting contents 30 c.cs.

In this case the meal left the stomach very quickly and after the disappearance of the meal the acidity rose.

There is no regurgitation of bile and considering the rapid exit of the meal and the rise in acidity, which is maintained, this was slightly suggestive of duodenal ulcer.

The acidity is not very marked.

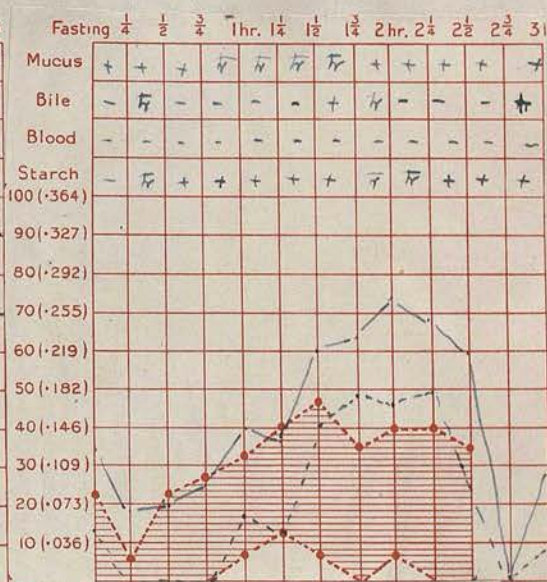
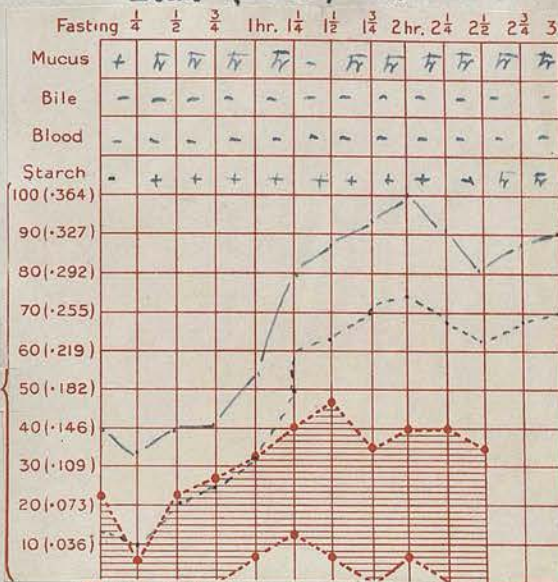
At operation no ulcer was found, but chronic appendicitis was present.

FRACTIONAL TEST MEAL IN TWO CASES OF

CHRONIC APPENDICITIS.

E.M. (Male) 29.

C.E. (Male) 33.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

.....represents free HCl.
 -----represents total acidity.

Fasting contents 70 c.cs.

No foul odour.

From the obvious delay of emptying noted by the presence of starch three hours after ingesting and the climbing acid curve, pyloric spasm can be diagnosed. This is usually found in cases of juxta-pyloric ulcer, but at operation performed later, no ulcer was found, so the condition was simply a reflex spasm of the pylorus from chronic appendicitis.

Fasting contents 50 c.cs.

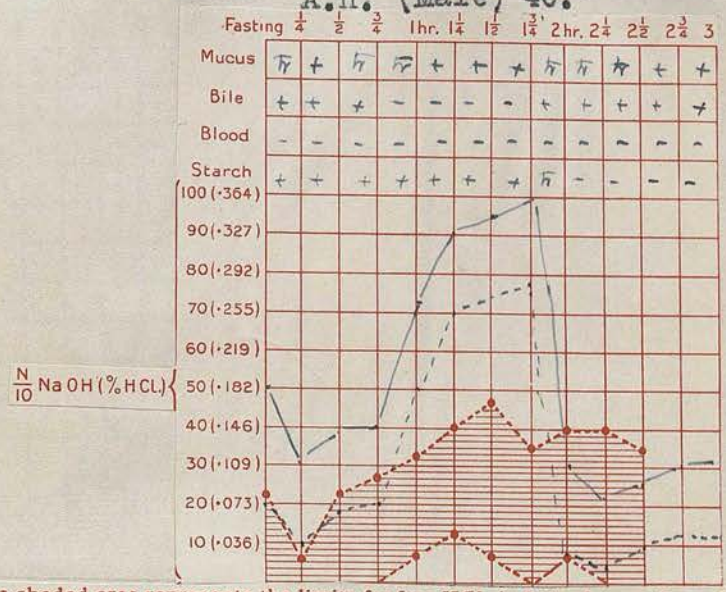
No foul odour.

There is delay in emptying, starch being present at the end of three hours. The curve rises fairly sharply till the second hour, after which it gradually subsides. There is also regurgitation of bile. This curve illustrates the faulty technique pointed out by E.C.Dodds, M.V.O., M.D., i.e. the tube had passed into the duodenum when the eleventh specimen was taken. This curve is slightly suggestive of duodenal lesion, but is not by any means definite. At operation, no lesion was found other than chronic appendicitis.

FRACTIONAL TEST MEAL FROM A CASE OF

CHRONIC APPENDICITIS.

A.H. (Male) 40.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.
 ——— represents total acidity.

Fasting contents 40 c.cs.

Bile was present in the first three specimens and reappeared in the eighth and was present until the twelfth specimen. The acidity was slightly above normal during the first three specimens, but afterwards rose rapidly until the reappearance of bile, when it fell back to normal limits. The meal left the stomach in normal time.

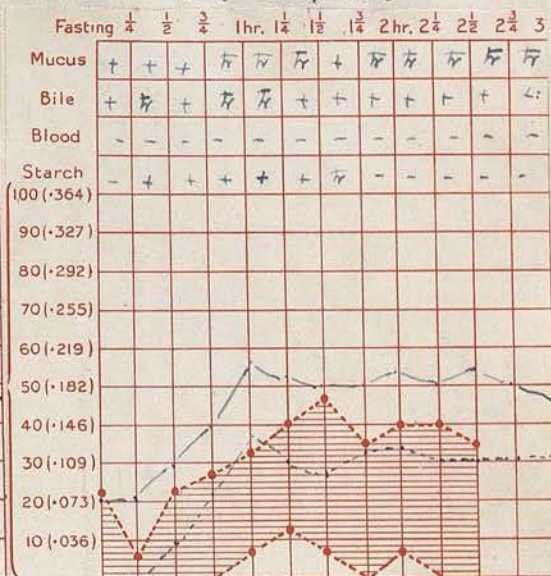
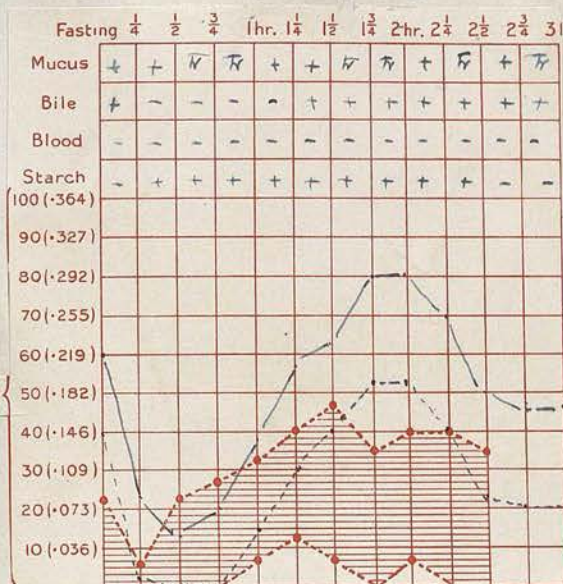
This is a simple case of hyperchlorhydria, presumably of reflex origin, chronic appendicitis being found at operation.

FRACTIONAL TEST MEALS FROM TWO CASES OF

DUODENAL ULCER

E.W. (Male) 80.

H.B. (Male) 64.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.

----- represents total acidity.

Fasting contents 40 c.cs.

Strongly acid.

Bile present.

No foul odour.

Stomach empty in normal time.

Bile present from sixth to twelfth specimens.

After initial drop, acidity rises and is maintained for a short time despite presence of bile, then drops to a lower level. This test meal does not give any definite information regarding any pathological condition present.

Fasting contents 20 c.cs.

Acidity normal, bile present.

Meal left stomach in normal time.

Bile is present throughout test, indicating patency of the pylorus.

The acid curve is slightly above normal and keeps at the same level till the end.

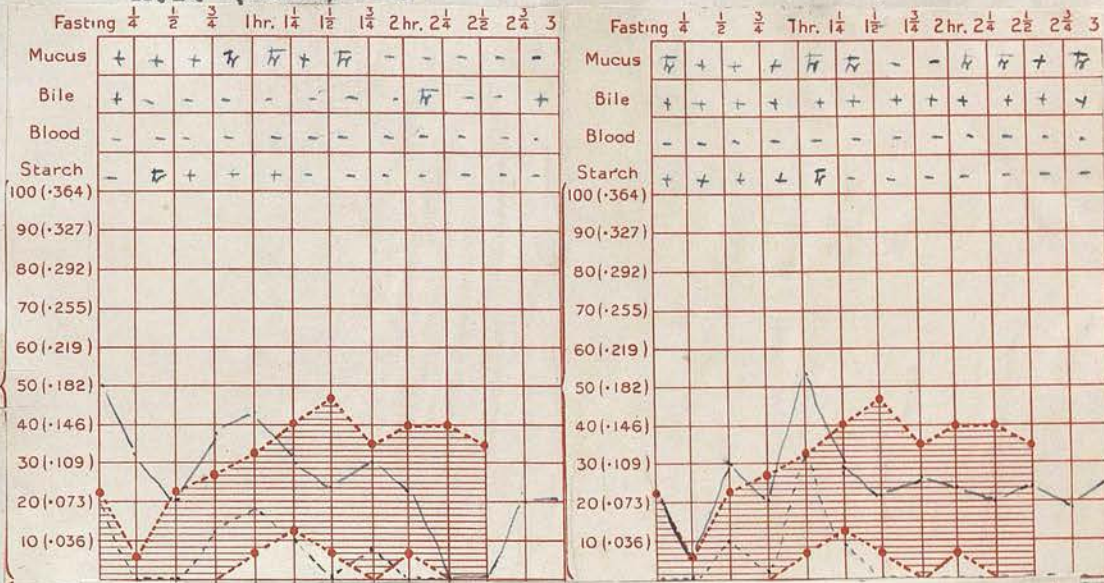
This test does suggest some pathological condition of duodenum. Chronic duodenal ulcer was found at operation.

FRACTIONAL TEST MEALS FROM TWO CASES

INDICATING HYPERTONICITY OF STOMACH

A.P. (Male) 59.

G.B. (Male) 44.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.

————— represents total acidity.

Fasting contents 25 c.cs.

Fasting contents 10 c.cs.

Strongly acid.

Acidity normal.

Marked hurry of the meal as it has left the stomach in one and a quarter hours. The acidity with the exception of the fasting contents is practically normal. In this case the fractional test meal indicated hypertonicity of the stomach.

Bile present in all specimens.

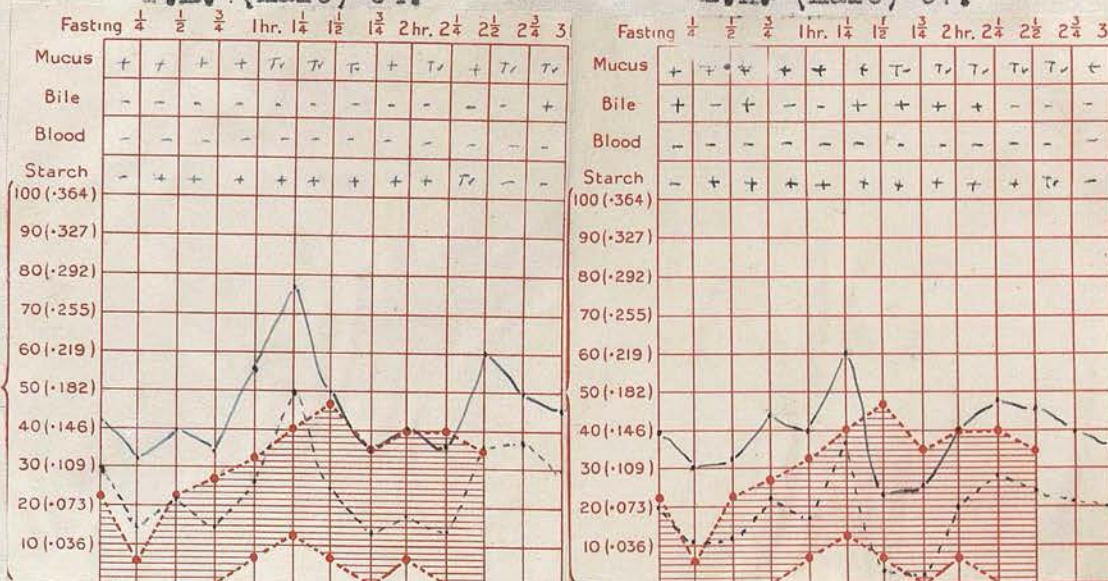
Marked hurry of the meal, as it has left the stomach in one and a quarter hours. After ingestion of the meal, acidity rises sharply, but drops to a low level after the meal has left the stomach. The presence of bile in all specimens indicates marked patency of the pylorus or regurgitation of the duodenal contents, from the nervous condition of the patient. The meal indicates hypertonicity of the stomach.

FRACTIONAL TEST MEALS FROM TWO CASES OF

SLIGHT HYPERCHLORHYDRIA

F.M. (Male) 54.

E.K. (Male) 57.



The shaded area represents the limits for free HCl. in 80% of normal people, and average rate of emptying (2-2½ hours).

..... represents free HCl.

----- represents total acidity.

Fasting contents 30 c.cs.

Stomach empty in normal time,

Acidity is slightly above normal, but there is nothing definite to note other than these points.

Fasting contents 60 c.cs.

Bile present in first and third specimens and from the sixth to the ninth inclusive. Slight delay in emptying of the meal. The acidity is slightly above normal, but again there is nothing definite.

Neither of these meals assist in the diagnosis except that of slight hyperchlorhydria.

DISCUSSION.

Despite the various fallacies which I have enumerated in previous pages, there is no doubt that the fractional test meal does give very useful information to the Physician, but it must also be remembered that of its own, it will not produce a diagnosis. In many cases in which the Physician is in doubt, a carefully done fractional test meal might give him a clue as to the real state of affairs. Taking the individual diseases one finds in my series, that in gastric ulcer, its only use comes in with helping in the diagnosis of an ulcer in the neighbourhood of the pylorus which produces pyloro spasm. It does not assist in any other way to diagnose an ulcer of the stomach.

In one case of penetrating ulcer of the lesser curvature, the fractional test meal was found to be very suggestive of duodenal ulcer and therefore it cannot be relied upon to any great degree.

With regard to duodenal ulcer, the results are more encouraging and in my series of cases I saw really only one case in which the test meal did not give any assistance. Four cases were diagnosed quite correctly, while in two, a pathological condition was suggested. One case, which at operation was found to be duodenal ileus, was suggested by the

test meal to be one of pyloro spasm. In the other case of pyloro spasm in this group, the ulcer was in the pyloric part of the duodenum.

In the case of carcinoma, the results were very flattering but, as there were only two cases in this group, one cannot take too much notice of the result. Still, it must be considered that in this disease the fractional test meal is of very great value.

I had hoped that the results in cases of chronic appendicitis might have been more uniform and that the fractional method might have been of some assistance to the Physician in helping him to decide in certain cases of gastric symptoms (without organic disease of the stomach) whether these symptoms might be referable to the appendix. Unfortunately, the results were very disappointing, and in the seven cases examined there were five different types of curves produced.

Fractional test meals were done on the two cases of pernicious anaemia simply out of interest and so that comparison might be formed between the achlorhydria of this disease and that produced from other causes, notably carcinoma.

In the four cases of achlorhydria, gastritis was diagnosed in three and the fourth case was found at operation to be due to volvulus of the colon.

This then was a case of reflex inhibition as before

stated; the most important point in the test meal diagnosis was the exclusion of carcinoma.

In the five cases which I have described as indefinite, three showed a high acidity and two showed hypertonicity of the stomach.

Taking a general view of the whole subject, one must admit that the fractional test meal does not assist the Physician much in cases of gastric ulcer (unless, as previously stated, the ulcer is in the neighbourhood of the pylorus), chronic cholecystitis or chronic appendicitis. It does afford very useful evidence in cases of duodenal ulcer and carcinoma. Furthermore, in cases of duodenal ulcer in which a gastro-enterostomy is suggested, the Surgeon is put on his guard against the possible development, after the operation of a jejunal ulcer, by knowing whether or not the acidity is marked. In practically every case of duodenal ulcer, there is a hyperchlorhydria, but in some cases it is more marked than others. Treatment to lower the acidity could be carried out and continued, and this would undoubtedly help to prevent the unfortunate complication which I have mentioned.

I agree with H. Maclean, M.D., M.R.C.P., (70) that a careful test meal would, in practically every case, prevent a carcinoma of the stomach from being missed

if the patient had definite gastric symptoms.

The fractional test meal is also of undoubted value in investigating cases of gastritis. All cases of gastritis have a low acidity and if patients have gastric symptoms and the Physician finds achlorhydria to be present, he not only knows exactly how to treat the patient, but at the same time he is more or less able to exclude carcinoma.

In the majority of cases complaining of gastric symptoms which come under the general Practitioner, there are very few who have definite organic disease. This being so, the treatment given is usually quite empirical. Suggestions are given for diet, for example, milk foods and a bismuth, magnesium and sodium bicarbonate mixture prescribed.

If the fractional test meal were in general use and patients were examined in this way, the Practitioner would, in most cases, have first of all a very good idea as to whether or not organic disease was present. Secondly, if organic disease were not present, then he would have one of three results. The case would either be:-

- (i) Hyperchlorhydria (with possible hypersecretion).
- (ii) Anormal acidity.
- (iii) Hypochlorhydria or achlorhydria.

If the first condition were present, then he would be able to institute treatment immediately, to counteract any symptoms referable to the high acidity. If the second condition were found, then he would probably find simple dietetic measures would produce the necessary cure. If the third condition were present, then any symptoms referable to the lack of acidity can be easily remedied by giving the patient an acid mixture or gastric lavage if excess of mucus be present.

If, however, the Practitioner, as a result of the examination, had any doubt regarding the possibility of a pathological condition being present, then he would not be justified in carrying out the simple measures until an absolutely negative diagnosis had been made either by himself or at Hospital.

One other useful piece of information which a Practitioner would gain, would be the knowledge of whether there was any delay in the passage of food from the stomach. The usual time allowed for a test meal to leave the stomach is from two to two and a half hours. If there still remains some of the meal at the end of three hours then a certain amount of delay is present.

In the absence of there being any indication of pyloro spasm, the most probable cause of this delay

is atony, always providing that the organic disease in the neighbourhood of the pylorus had been excluded. If, on the other hand, the meal leaves the stomach under normal time, then hyperperistalsis is present which, in the absence of a duodenal lesion or achylia gastrica, is probably functional in origin.

The necessary treatment can then be given with greater prospects of success than if the Practitioner was not quite sure of the real state of affairs with regard to the motor power of the stomach.

In conclusion, I should like to state that all cases of hyperacidity should be viewed with suspicion, as there is always the possibility of an ulcer being present or of an ulcer developing if the condition remains untreated.

CONCLUSIONS.

Before giving my conclusions, there are a few observations I should like to make.

1. A radiological examination is a long and tedious process which requires the services of an experienced examiner, and usually necessitates the patient going to a hospital or a private Radiologist.
2. It is very expensive and, unless the examination is absolutely essential, I do not think it should be advised.

If the patient lives in a town possessing a hospital, the inconvenience of attending hospital is not so marked as in those cases living in the country. In the latter case, the patient has to travel to a hospital, have the examination and possibly stay the night, which means giving up a good deal of time. Should the patient be ill as the result of suspected disease, then in order to be X Rayed it is essential that he becomes an in-patient at the at the hospital. If he is able to travel and go for the examination, then besides the inconvenience previously mentioned, there is a great strain on his constitution by the preparation necessary for the examination, the journey to the hospital and then the examination.

With regard to test meals, we have an entirely different state of affairs. The patient can remain at home and, once the discomfort of swallowing the tube is passed, he can sit and read or, in a case of a female patient, knit or sew. At the longest, the examination only lasts three hours and the patient does not have any strain to suffer whatever. Furthermore, the examination can be done whether the patient is ill or not, always providing, of course, there has been no hemorrhage within the previous twenty-four hours. A Doctor can remove the specimen to his home and carry out the rest of the examination in the evening. In the matter of simplicity and the amount of time and energy expended, the fractional test meal has undoubtedly great advantages over a radiological examination.

When we come to consider the results of the respective examinations, we are forced to admit that, in most cases, the X Ray gives us, on the whole, more accurate results. In connection with this point, the X Ray tells us the important fact, namely, the exact site of the lesion. This knowledge is absolutely essential before the patient can be treated by the deep therapy, which I have mentioned previously.

Taking the individual diseases, the X Ray

results are much better in cases of gastric ulcer. In these cases, the test meal can only help us provided the ulcer is in the neighbourhood of the pylorus. Ulcers on the lesser curvature, or on the posterior wall of the stomach, or in any other position than juxta-pyloric do not produce any typical test meal result.

In duodenal ulcer, the X Ray superiority is not so marked. In fact, in many cases, the test meal results are just as good and in some cases better. The chief difficulty which the Radiologist encounters in duodenal ulcers is the fact that ulcers in this neighbourhood are so difficult to demonstrate, and deformity of, and inability to fill, the duodenal cap is, in many cases, the most which the Radiologist can see in the examination of this condition. We know that the same deformity, which is so often described in connection with duodenal ulcers, can also be produced by adhesions, and therefore in many cases no absolutely positive diagnosis can be made.

With test meals, the curve in most cases is very typical; the fasting juice is usually highly acid with a marked drop in acidity after ingesting the meal and an immediate rise within the next three or four specimens. The high acidity is usually maintained to the end, and one other feature in many

cases, is the rapid exit of the meal from the stomach. Still, we must remember that in some cases of duodenal ulcer, it is possible to have a normal test meal result, as I have shown in one of my own cases. Again, it is possible to have what appears to be a typical curve of a duodenal ulcer being produced by chronic appendicitis, or even in a case where no pathological condition can be demonstrated.

In cases of carcinoma, I think the test meal is perhaps of more importance than X Ray in the early diagnosis of this disease, provided it is carefully performed and the test is done for lactic acid. There are several opinions for and against the importance of lactic acid being present, but the figures of H. Maclean, M.D., M.R.C.P., (71) on the subject, in connection with this question, are very suggestive.

The most important part of this meal, in cases of suspected carcinoma, is the fasting juice. If the fasting juice contains charcoal, has a foul odour and a high acidity, then carcinoma should be immediately considered. If there is low acidity with a good deal of mucus, and lactic acid is present, then the test meal diagnosis of carcinoma is practically certain to be correct.

The X Ray very seldom misses a well marked

carcinoma but occasionally it does so, as happened in one of my own cases. The difficulty of recognising the disease in the early stages is great, and it is during the early stages of the disease that the diagnosis is of most importance because of the question of operative interference. The earlier the disease is recognised, the brighter are the prospects of good operative results.

Although hyperchlorhydria does not of itself produce pain, nevertheless there are definite symptoms present in this condition which are referable to the high acid content of the stomach. Further, there is always the possibility that an ulcer may develop as the result of its continuation.

Prevention is always better than cure and, if by treatment of a case of marked hyperchlorhydria, duodenal or even a gastric ulcer can be prevented, then we can be satisfied that good work has been done.

I should think that if test meals were done more often than the Practitioner would probably, in many cases, be able to make a positive diagnosis, in which, without the meal, he was in doubt; or, on the other hand, in many cases the test meal might throw doubt on a diagnosis and cause the Practitioner to have a further investigation.

I do not think that the test meal should be made the last Court of Appeal, but rather that it should be the first court in which the examination takes place. Here, I should like to state that the Physician, or Surgeon, must not allow an X Ray examination or a fractional test meal to take the place of a careful history and a careful clinical examination. The X Ray and fractional test meal should be merely confirmative.

My Conclusions are as follows:-

1. Gastric Ulcer. X Ray is undoubtedly superior to test meals in usefulness.
2. Duodenal Ulcer. Usefulness of X Ray with test meal is about equal. X Ray, of course, gives more accurate information.
3. Carcinoma. Test meal is more useful in diagnosing an early case.
4. Gastritis. The X Ray does not give any help other than in assisting to exclude carcinoma or ulceration, whereas the test meal is very useful, besides aiding the Physician in the diagnosis, it also helps him to exclude carcinoma definitely.
5. Functional Disease. The test meal gives, on the whole, more help to the Practitioner than the X Ray. In cases of functional disease, the X Ray does give a certain amount of help, but it is chiefly

in a negative sense, namely, in excluding organic disease, although it does, to a certain extent assist in the diagnosis of hypertonicity and atony. The test meal, on the other hand, is very useful in helping the Physician to diagnose the various conditions of the gastric secretion, besides hypertonicity and atony of the stomach.

I shall finish by stating that if the Physician, or Surgeon, after a careful history and clinical examination has been done, is undecided as to the diagnosis, then a test meal should be performed. If there is still doubt, or if more accurate information is desired, then a radiological examination should be carried out without delay.

Finally, both the results of X Ray examination and the fractional test meal, unless they agree with the history and clinical findings, should be accepted with great caution, or ignored, or else a further examination should be carried out.

R E F E R E N C E S.

1. Martin E, Rehfuss, M.D., Diagnosis and Treatment of Diseases of the Stomach. page 102, etc.
2. J. A. Ryle, M.D., F.R.C.P., Gastric Function in Health and Disease. Appendix page 145.
3. M. Haudek, M.D., MUENCH. MEDIZIN. WOCH. 22nd November 1910. page 2463.
4. G. H. Orton, M.D., D.M.R.E., Lancet. 16th November 1929. page 1043.
5. Moody, Van Nuys and Chamberlain. Journ. Amer. Med. Assoc. 1923. page 151 - quoted by M. Rehfuss, M.D., Loc. Cit. page 375.
6. T. Izod Bennett, M.D., M.R.C.P., The Stomach and Upper Alimentary Canal in Health and Disease. page 255.
7. F. N. White, M.D., Med. Clin. of North Amer. Vol. 11, No. 5, page 1413.
8. E. Hollander, M.D., Journ. of Amer. Med. Assoc. lxxx. No. 1, page 29. 6th January 1923.
9. W. W. Hamburger, M.D., Amer. Journ. of Med. Science 155, page 204. February 1918. (As quoted by E. Hollander, M.D.,) Loc. Cit. page 29.

10. F. N. White, M.D., Med. Clin. of North Amer.
Vol. 11, No. 5, page 1413.
11. A. E. Barclay, M.D., Lancet 14th December 1929.
page 1272,
12. L. R. Broster, O.B.E., M.D., F.R.C.S., British
Med. Journ. 5th June 1926. page 938.
13. A. E. Barclay, M.D., Lancet 7th December 1929.
page 1213.
14. Martin E. Rehfuss, M.D., Loc. Cit. page 606.
15. W. W. Hamburger. Amer. Journ. of Med. Science
155, page 204. February 1918. (As quoted by
E. Hollander, M.D.,) Loc. Cit. page 29.
16. A. E. Barclay, M.D., Lancet 14th December 1929.
page 1272.
17. Martin E. Rehfuss, M.D., Loc Cit. page 680.
18. A. E. Barclay, M.D., Lancet 7th December 1929.
page 1213.
19. L. R. Broster, O.B.E., M.D., F.R.C.S., Loc. Cit.
page 938.
20. M. Haudek, M.D., British Med. Journ. 3rd August
1929. page 173.

21. A. J. Walton, M.S., F.R.C.S. British Med. Journ. 25th May 1929. page.941.
22. T. Izod Bennett, M.D., M.R.C.P. Loc. Cit. page 238.
23. M. Haudek, M.D., British Med. Journ. 3rd August 1929. page 175.
24. Martin E. Rehfuss, M.D., Loc. Cit. page 390.
25. M. Haudek, M.D., Loc. Cit. page 175.
26. Martin E. Rehfuss, M.D., Loc. Cit. page 381.
27. A. E. Barclay, M.D., Lancet 7th December 1929. page 1213.
28. Martin E. Rehfuss, M.D., Loc. Cit. page 391.
29. L. R. Broster, O.B.E., M.D., F.R.C.S., Loc. Cit. page 938.
30. Martin E. Rehfuss, M.D., Loc. Cit. page 251.
31. H. Maclean, M.D., M.R.C.P., Modern Views on Digestive and Gastric Diseases. page 140.
32. L. R. Broster, O.B.E., M.D., F.R.C.S., Loc. Cit. page 931.
33. J. A. Ryle, M.D., F.R.C.P., Loc. Cit. page 37.

34. G. H. Orton, M.D., D.M.R.E., Loc. Cit. page 1045.
35. M. Haudek, M.D., British Med. Journ. 3rd of August 1929. page 175.
36. M. Haudek, M.D., Loc. Cit. page 175.
37. M. Haudek, M.D., Loc. Cit. page 175.
38. H. Maclean, M.D., M.R.C.P., Loc. Cit. page 135.
39. M. Haudek, M.D., Loc. Cit. page 175.
40. Martin E. Rehfuss, M.D., Loc. Cit. page 102.
41. J. A. Ryle, M.D., F.R.C.P., Loc. Cit. Appendix page 145.
42. H. Maclean, M.D., M.R.C.P., Loc. Cit. page 99.
43. G. E. Beaumont, M.D., F.R.C.P., and E. C. Dodds M.V.O., M.D., Recent Advances in Medicine page 178.
44. Martin E. Rehfuss, M.D., Loc. Cit. pages 293-294.
45. G. E. Beaumont, M.D., F.R.C.P., and E. C. Dodds M.V.O., M.D., Loc. Cit. page 195.
46. S. Wyard, M.D., M.R.C.P., Handbook of Diseases of the Stomach. page 41.

47. Martin E. Rehfuss, M.D., Loc. Cit. page 299.
48. J. A. Ryle, M.D., F.R.C.P., Loc. Cit. page 26.
49. A. F. Hurst, M.A., M.D., F.R.C.P., Brit. Med. Journ. 3rd November 1928. page 779.
50. T. Izod Bennett, M.D., Loc. Cit. page 240.
51. A. J. Walton, M.S., F.R.C.S., Loc. Cit. page 941.
52. T. Izod Bennett, M.D., Loc. Cit. page 254.
53. L. R. Broster, O.B.E., M.D., F.R.C.S., Brit. Med. Journ. 3rd November 1928. page 788.
54. T. Izod Bennett, M.D., Loc. Cit. page 253.
55. H. Maclean, M.D., M.R.C.P., Loc. Cit. page 108.
56. S. Wyard, M.D., M.R.C.P., Loc. Cit. page 21.
57. J. A. Ryle, M.D., F.R.C.P., Loc. Cit. page 26.
58. S. Wyard, M.D., M.R.C.P., Loc. Cit. page 31.
59. J. A. Ryle, M.D., F.R.C.P., Loc. Cit. page 30.
60. E. C. Dodds, M.V.O., M.D., Lancet 16th November 1929. page 1042.
61. S. Wyard, M.D., M.R.C.P., Loc. Cit. page 31-32.
62. J. A. Ryle, M.D., F.R.C.P., Loc. Cit. page 27.

63. T. Izod Bennett, M.D., Loc. Cit. page 251.
64. J. A. Ryle, M.D., F.R.C.P., Loc. Cit. page 36.
65. H. Maclean, M.D., M.R.C.P., Loc. Cit. page 48.
66. Martin E. Rehfuss, M.D., Loc. Cit. page 334.
67. A. J. Walton, M.S., F.R.C.S., Brit. Med. Journ. 25th May 1929, page 941.
68. G. E. Beaumont, M.D., F.R.C.P., and E. C. Dodds, M.V.O., M.D., Loc. Cit. page 187.
69. J. A. Ryle, M.D., F.R.C.P., Loc. Cit. page 26.
70. H. Maclean, M.D., M.R.C.P., Loc. Cit. page 48.
71. H. Maclean, M.D., M.R.C.P., Loc. Cit. page 100.