flexure. If this does not succeed, a sigmoidoscope must be passed and the rubber tube introduced through it. If this also fails, the abdomen must be opened. On pulling the distended colon upwards, a tube can be passed into it from the anus, and the bowel is then emptied. After this has been done it may be possible to pass the tube daily in the manner already described, as the obstruction originally caused by the pelvi-rectal achalasia is always increased by the kink produced by the greatly dilated pelvic colon where it joins the undilated rectum. If, however, this eventually becomes impossible, an anastomosis should be made between the undistended rectum and the terminal ileum, or, preferably, the under surface of the extreme end of the pelvic colon. It is, however, exceedingly difficult to do this, and it may even be quite impossible owing to the small size of the rectum and to its situation deep in the pelvis. In such cases nothing short of excision of the whole of the dilated colon is likely to give relief.

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RADIOLOGICAL EXAMINATION IN ORGANIC DISEASES OF THE COLON:

THE OPAQUE ENEMA METHOD.

BY

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THE clinical evidence presented in most cases of colonic disease is meagre, variable, and often unreliable.

The sigmoidoscope will give direct evidence if the lesion is within its reach, but unfortunately this does not often happen. At its best, this form of examination only covers the last few inches of the colon itself. On account of the low malignancy of the majority of cancerous growths of the colon, their early diagnosis is of great importance, and any method of examination whereby direct evidence may be obtained before operation is valuable.

The radiological examination, using some opaque fluid as the medium, if carried out correctly, will give reliable and definite information in diagnosing the presence of an organic lesion of the colon. It is, of course, not always possible to distinguish between certain types of lesion, such as tuberculosis and carcinoma of the gut, but the fact remains that by a radiological examination the disease may be detected and located, which is of considerable surgical importance.

The radiological methods at command are: (1) the opaque meal given by the mouth and followed through to the anus—at one time the only routine in use, and (2) the opaque enema. Both methods have their advocates, but those who have had the opportunity of examining a number of colonic cases will have no hesitation in deciding which of the two is the more reliable. I entertain no doubt that the opaque enema is the only practical way of making a detailed examination of the lumen of the large gut. It is, in fact, as valuable as the opaque meal in the detection of gastric lesions.

Advocates of the opaque meal examination may say that a colonic obstruction can be detected in this way, but this is certainly not correct in a number of mechanical obstructions due to new growths. At its best it is unreliable; I have seen cases of colonic carcinoma where there has been no delay or obstruction in the passage of the meal from

the mouth to the anus, and yet there has been complete obstruction to the opaque enema. The reason for this has not been satisfactorily explained, but the fact remains.

The two chief disadvantages attached to the opaque meal method are: (1) That the examination is prolonged; several days, even weeks, may be required before the colon clears itself, and the final result, even then, is unreliable. (2) The second disadvantage is that colonic haustration or segmentation is very marked, the uneven distribution of the opaque salt rendering a detailed examination almost impossible.

The advantages of the opaque enema are that the examination is rapid, the whole gut being filled from rectum to caecum in a few minutes; that the almost complete absence of haustration renders small filling defects of the lumen easily detectable; and that if the enema is properly administered there is practically no discomfort to the patient.

The disadvantages are few and insignificant, compared with the data obtainable. My colleagues say it is a "messy" job, but except for occasional accidents not a drop of the opaque substance used should escape outside the body. Excluding accidents, a "mess" is indicative of faulty technique. The alleged discomfort for the patient has already been dealt with. It is a curious fact that the large majority of patients display no concern whatever, even when the colon is fully distended from rectum to caecum. This is possibly due to the preparatory wash-outs.

METHOD OF EXAMINATION.

Unless the opaque enema examination is carried out with careful attention to technical details it may lead to serious errors in diagnosis, discomfort to the patient, as well as to the operator, and its value as a diagnostic agent will be lessened.

Preparation of the Patient.

As our object is to inject a foreign substance in an organ which normally is already full, a clearance of its contents is essential. In other words, the colon must be free of faeces. Anyone who has seen the opaque fluid obstructed by a hard mass of faeces will realize the importance of efficient clearance, as its appearance is remarkably like the obstruction of a new growth.

Castor oil is the most reliable aperient. This should be administered at least thirty-six hours before the examination, for unless the effect has passed off by the time operations begin there is a risk of the opaque enema being returned. Light diet follows the aperient. A plain water enema is administered the night before and a second on the morning of the examination. This procedure will ensure an empty colon. The medical man in charge of the case should fully realize the importance of this preliminary preparation indicated by the radiologist. Serious errors in diagnosis may otherwise be made.

Apparatus.

A douche-can of the usual pattern, in which the outlet is about an inch from the bottom, is the most suitable. Any sediment that may collect can thus settle down without blocking the tube. I have tried several other patterns, but this type is the best. About four feet of thick-walled rubber tubing is attached to the can and to the end a Higginson's syringe is added, the valves of the syringe being removed, as they would soon become blocked. The use of the bulb of the syringe will be discussed later. The acorn-shaped rectal nozzle made in metal will be found to be the most suitable. It throws a shadow, so that its correct position can be verified before the injection takes place, and its shape renders it less liable to slip out.

The douche-can, which is placed about two feet above the patient, is now filled three-quarters full ($1\frac{1}{2}$ pints) with the barium emulsion (Ramul No. 3) warmed to body temperature. The clip which is placed on the tube to control the flow is released and the emulsion run up to the nozzle; this excludes the air. The clip is now closed. The end of the nozzle only is smeared with a small quantity of vaseline. If the whole is lubricated there is a tendency for it to slip out during the injection. The patient, suitably attired, lies on his back, with a towel under the buttocks and a pad of cotton-wool under the sacrum. With nervous patients,

or where there has been any difficulty in retaining the preparatory wash-outs, it is as well to place a mackintosh under the towel. This, however, is not often necessary.

The nozzle should be inserted very gently, care being taken to see that it is pushed well home. Before commencing the flow of barium emulsion a glance is taken on the screen to ascertain whether the position of the nozzle is correct. The tip should be on a level with, or above the level of, the symphysis pubis, never below. This procedure will prevent accidental ejection, but will not necessarily prevent an accident that once happened to me when the nozzle was inserted into the vagina by an inexperienced nurse. The pad of wool, which is already in position under the sacrum, is now tucked firmly round the enema tube. This will keep it in position and incidentally prevent leakage. The clip can now be released and the filling of the colon commenced. The patient is instructed to say whether any pain or discomfort is felt during the examination. Very few experience any uncomfortable symptoms whatever if the injection is carried out gently and without haste.

The S-shaped pelvic colon quickly fills. A short delay may occur at the junction of the sigmoid and descending colon, due to a sphincteric action. Some delay may also be noted at the splenic flexure. In a normal case the colon should be completely filled in about five to eight minutes. In quite a number of cases the enema is seen to pass right through the ileo-caecal valve and occasionally the appendix itself is filled.

Pressure on the ball of the Higginson syringe is found to be of considerable value during the injection. Not only can the flow be hastened, but, what is still more important, any alteration in the colonic tension is at once conveyed to the hand. Experience enables one to become very sensitive to any alteration or variation of this colonic tension—so much so that it becomes possible to distinguish between the increased tension caused by muscular contraction, such as peristalsis or spasm, and that of obstruction by a new growth. In dealing with a difficult patient it is a wise precaution to glance occasionally at the anal region on the screen; a leakage of the emulsion will in this way be at once detected before any quantity escapes.

As soon as the caecum is seen to be fully filled the flow is shut off, the nozzle removed, and the pad of cotton-wool, used to prevent leakage, wrapped round it on removal. If this is done not a drop of the emulsion should escape during the examination.

Systematic examination of each section of the gut is now carried out, careful palpation being used where possible. It will be found necessary to turn the patient in various directions to obtain a clear view of the coils lying in the pelvis as well as when examining the flexures. In some cases even this procedure will not throw the pelvic coils clear of one another. I overcome this difficulty by injecting a few ounces of warm water; this dilutes the contents of the lower bowel, rendering the shadow less dense, and one coil can in this way be seen through the other.

Radiographs may be taken to illustrate any abnormal condition, but they rarely give any more information than what has already been obtained from the screen examination, where palpation has been utilized.

The patient is now allowed to discharge the colonic contents, and this is followed by a final *fluoroscopic* examination, which is specially important when there is a question of diverticulitis.

These technical details have been fully discussed as the success of the examination and the attainment of its full diagnostic value depend on their observance.

MORPHOLOGY AND TOPOGRAPHY OF THE COLON.

Tone.

A considerable variation in tone occurs in the colon, similar to that seen in the rest of the intestinal tract. This is determined to a great extent by the mental attitude of the patient. Apprehension, for instance, may be present in this form of examination. The fear of being unable to retain the enema weighs heavily on some patients; the result, especially noticeable in females, is an abnormal increase in the general tone, amounting even to spasticity of

the colon during the examination. These cases require careful handling if the examination is to be carried to a successful termination.

I have already drawn attention to this variation of tone in respect to the stomach—it alters day by day, almost hour by hour. A hypertonic stomach to-day, in fact, may be a hypotonic stomach to-morrow, and this is equally true of the colon. It is noticeable that this tendency to hypertonicity occurs more frequently in the descending section. If it is purely a transitory condition the contracted lumen will relax before the termination of the examination, showing a fully filled gut. If of a more permanent nature, as is sometimes seen in spastic constipation, no relaxation takes place. A local spasm is of frequent occurrence, but the smooth symmetrical constriction, not infrequently altering its position, should not give rise to much difficulty in diagnosis. This condition may be found in any section.

Haustration.

One of the advantages of the opaque enema examination is that it does away with colonic haustration. The colon is filled out to its fullest extent like the inner tube of a tyre, any defect in filling being thus readily detected. This absence of haustration, however, is not necessarily present during the whole of the examination. Each section should be carefully examined, using palpation, while it is free of segmentation. Even if it is somewhat persistent, as may occasionally happen, the fact that it is symmetrical and not unevenly broken up, as is seen when an opaque meal has been administered, will render the examination satisfactory and accurate.

Topography.

Owing to the large variation in the position of a normal large gut, it is impossible to give any reliable landmarks. Probably the rectum and splenic flexure are the most constant in position, the transverse colon, hepatic flexure, and caecum being the most variable.

It may be of advantage here to describe the filling of a normal colon. The fluid rapidly fills the S-shaped pelvic colon, a short delay occurring at the sigmoid sphincter, as I call it. Although there is some doubt as to the existence of a muscular sphincter at the junction of the pelvic colon and sigmoid, radiologically there is without doubt a narrowing of this juncture—usually most pronounced at the commencement of the injection; in any case a definite delay in the flow may be anticipated here. The descending colon readily fills. This is the narrowest portion of the colon.

The splenic flexure fills in its turn. This is usually high up under the costal cartilage; a deep breath, however, will bring it down within reach of the palpating hand. One is apt to get the impression that there is delay in the filling of this flexure. On investigation, however, this will not be found correct. The explanation is that this loop is being viewed end on, and also that the shadows of the two limits of the loop overlap one another, the column of fluid in the proximal side not getting clear of the distal limb for some six inches or more below the upper limit of the flexure. This condition can be verified by palpation.

The fluid now readily flows across the transverse colon as far as the ascending section; the caecum takes somewhat longer to fill completely. Early carcinomata of the caecum will be missed unless care is taken to fill it as completely as possible.

Frequently the fluid passes into the ileum and even into the appendix. This flowing into the ileum has hitherto been attributed to an incompetent ileo-caecal valve. I do not, however, think that this is correct in all cases. The valve was not designed to stop the back flow of a fluid such as is used in this examination.

Detailed Examination of the Fully Filled Colon.

Many puzzling defects will be noted during the process of filling the colon. The explanation is probably the result of spasm or local air-locks. In any case, it is wise not to give an opinion on a case unless the colon is completely filled. The caecum should be seen fully filled before commencing a detailed examination. The inflow, of course,

must be carefully watched, as much valuable information will probably be obtained during the passage of the opaque fluid. Many a puzzling defect noted while the colon is filling will have disappeared by the time the colon is filled to its fullest extent.

DEVIATION FROM THE NORMAL DUE TO CAUSES OTHER THAN ORGANIC DISEASE.

Dilated Rectum.

The pelvic section may be dilatable to an unusual degree. This may occur in cases of constipation. The dilatation, which may be considerable, is limited to the rectum and pelvic colon. In these cases there appears to be a complete loss of muscular tone, and nerve impulses are probably no longer sent out from this section, even when grossly overloaded. The whole colonic mechanism is thus put out of gear, and troublesome constipation may ensue.

Extra Loops.

The more common sites for extra loops are as follows:

1. Redundant sigmoid.
2. Descending colon—about the level of the crest of the ileum.
3. Both flexures.
4. Ascending section.

It would be an interesting study in comparative anatomy to ascertain whether any of these loops correspond to analogous conditions in the lower animals. In other words, are they of ancestral origin?

No special description is needed, except possibly of the redundant sigmoid, which occurs more frequently than the others. This extra loop may reach remarkable dimensions, extending up as far as the transverse section. Although congenital—possibly of ancestral origin—this extra looping does not cause symptoms, although I sometimes wonder whether it might not do so in some circumstances, as a number of patients in whom this condition is found, and who present themselves for this examination, complain of vague abdominal symptoms. No apparent obstruction, however, is noticeable in such cases.

While the degree of looping is variable, the indication of its presence is constant in position; for instead of the column of fluid following an outward direction after filling the pelvic colon, it is seen creeping upwards from the upper limit of the S, following the loop round and joining the descending section at its normal level.

Jacksonian Membrane.

This is a rare condition, due to the presence of a membrane in the region of the hepatic flexure. The membrane is stretched over the gut, flattening it out to a greater or lesser extent. It may be present without giving rise to symptoms. The smooth outline of a narrowed section of the gut in the region of the hepatic flexure, causing no great degree of obstruction, should easily differentiate it from a new growth.

Enteroptosis.

Only a general description will be given of the part played by the colon in this baffling condition. Considering its extreme frequency, it is surprising that not more is known of its cause. Let it be clearly understood that radiologists can only state the *position* of the various sections, the muscular tone, and the rate at which the contents pass through. The deductions must be left to the physician. It is possible to have an extreme degree of enteroptosis without any symptoms. In fact, the intestinal tract may be functioning perfectly normally, in spite of its low position. Therefore, the position of the organs is not necessarily the deciding factor in these cases.

There is another point. At what level does enteroptosis begin? To some radiologists every case examined has some degree of ptosis of the transverse colon; to others it is the hepatic flexure which offends. The whole subject needs revision—at any rate from the radiological point of view. We do not yet know to an inch on what level our organs

should be. I hope to return to this subject at some future time. Briefly, colonic ptosis may be classified as follows:

1. Caecal—so-called pelvic caecum.
2. Right half of colon down (single flexure).
3. Splenic "drag," due to the splenic flexure remaining high up in its normal position, thus taking the weight of a loaded right half of colon. This frequently gives rise to pain under the left costal margin and may be diagnosed as of gastric origin.
4. Ptosis of both flexures with, of course, the transverse colon.

The examination of suspected cases of enteroptosis by the opaque enema has certain advantages over the meal. In the first place, there is a saving of time, as the whole colon can be examined at one sitting. Several days may otherwise be necessary before the meal reaches its journey's end. Secondly, the functioning properties of each section can be more accurately gauged.

It is, of course, necessary to examine the patient in the upright and recumbent positions, palpation being used to see if it is possible to manipulate the gut into its normal position. In addition, an opaque meal is given to ascertain the position of the stomach to the colon.

If the patient now attempts to evacuate the bowel, a second examination will determine and locate the residue, giving an indication of its emptying powers.

Adhesions.

Fixation of sections of the gut that should normally be free, with or without narrowing of the lumen, indicates the presence of adhesions. Adhesions of the large gut are rare, and care should be exercised in their diagnosis, as frequently there is apparent fixation owing to muscular contraction of the abdominal wall preventing efficient palpation. The caecum is often difficult to manipulate on account of its low position in the pelvis. Raising of the buttocks and deep respiration will cause it to move up if not fixed by adhesions.

Determining the Relation of Abdominal Tumours to the Colon.

A tumour may be felt through the abdominal wall. Its relation to the large gut may be of considerable surgical importance. This is easily ascertained by rendering the colon visible by an opaque enema. Occasionally the tumour will be found to be so closely connected with it as even to alter its lumen, but unless this alteration gives the irregular stricture characteristic of a new growth it must be considered as a tumour originating outside the gut, involving it only as a secondary condition. A tumour in the left flank, diagnosed as a growth of the descending colon, was shown by this method to be pressing on the gut, flattening it out, but not part of it. A detailed examination proved the lump to be an enlarged low kidney—a hypernephroma. The surgical value of this information need not be emphasized.

Pressure of Gall Bladder.

Pressure on the gut in the region of the hepatic flexure of an enlarged gall bladder may sometimes be detected.

ORGANIC LESIONS.

The presence of the following pathological conditions can be determined by means of the opaque enema:

1. New growths.
2. Diverticulation.
3. Tuberculosis.
4. Polypus (rectal).
5. Benign tumours—adenoma, fibroma, lipoma.
6. Chronic ulcerative colitis.

New Growths.

Here the diagnosis is dependent on (a) obstruction, (b) distortion of lumen. In the very early stages, while the growth is small, and before it encircles the whole lumen of the gut, detection is very difficult, unless a section that can be easily manipulated is involved.

While these early new growths are the type most frequently missed by the opaque enema examination, patients rarely come for the examination until the disease is well advanced. In respect to the obstruction resulting

from the presence of a new growth it is of interest to note that the passage of an opaque meal given by the mouth may be quite unobstructed. In other words, there may be no delay whatever and yet the obstruction will be complete to the opaque enema. Various suggestions have been made to account for this phenomenon, but my impression is that a channel through the new growth is moulded—probably into the shape of a funnel—by the onward passage of faeces, a valve-like closure taking place when the enema is administered. In any case, it is rare for a colonic growth to be present without giving rise to definite obstruction to the passage of the opaque enema.

The first indication of this obstruction is the sudden increase in colonic tension—imparted to those who are able to appreciate it—through the rubber ball of the modified Higginson syringe already mentioned. The column of the barium fluid ends abruptly as it comes up against the growth. In other words, it is straight-faced. Gradually a small amount may be enticed through the stricture. Care must be taken at this stage not to use force, otherwise damage may be done or the enema may be returned. Once the emulsion has got through the narrowed section, the extent of the disease can be gauged. The narrowed channel is usually irregular and tortuous, similar to a new oesophageal growth. A smooth in outline, care should be taken to eliminate local spasm; at the same time it must be remembered that in some cases of annular growths the stricture may be smooth, but then it is permanent. Palpation here may be of considerable use, for although no actual tumour can be felt, the rolling of the suspected area of colon from side to side under the fingers will impart a definite sensation of thickening of the wall.

The most difficult section to examine is the pelvic colon and first part of the sigmoid. The coils tend to overlap one another and considerable ingenuity is necessary to disentangle the shadows, especially as palpation is not possible in this portion of the gut. How, by injecting water, this difficulty may be overcome has already been described. A new growth involving the caecum may be overlooked or a wrong diagnosis of diseased colon may be made, unless care is taken that this portion is fully filled. There is a tendency to what I take to be an air-lock in this region, giving an irregular outline to the caecum. Palpation, however, will help it to fill to its fullest extent, but if this is unsuccessful the object will be achieved by turning the patient on to the face for a few minutes. Dilatation of the distal side of the obstruction is by no means unusual.

As previously mentioned, the opaque enema is the only satisfactory method of detecting the presence of narrowing or distortion of the gut, and the extent of the disease.

Tuberculous Disease.

Although a rare condition, tuberculous disease may be considered here owing to the fact that it closely resembles a new growth in its radiological appearances.

While tuberculous disease certainly causes narrowing and distortion of the gut, this is usually limited to one side, not involving, as with a new growth, the whole lumen. The proximal half of the colon is commonly implicated. The lesion is usually more extensive and the obstruction is seldom so complete as when caused by a new growth. The history of the case will also assist a correct interpretation of the findings. It is, however, by no means easy to distinguish between these two lesions. Differential diagnosis is also difficult between (a) adhesions, (b) actinomycosis, (c) abscess, and (d) extrinsic tumours.

Colonic Diverticulation.

This condition is more frequent than is generally supposed, but it does not necessarily give rise to symptoms unless inflammation supervenes. It is by no means uncommon in patients over 45. This pouching or sacculation of the colon is probably the result of some defect in the muscular coat, congenital or acquired. The diagnosis depends on the filling of these diverticula with the opaque fluid, and are either seen as bud-like projections, while the gut is fully distended, or as button-like shadows left behind after evacuation. They may be sessile or pedunculated, and are situated outside the limit of the gut. Examination immediately after evacuation may show a few of these saccules, but

many more will be detected if the examination is made again in twenty-four hours.

I have found that diverticula may remain filled with the opaque fluid for several weeks after the enema, and this even after vigorous irrigation of the colon. What part diverticula play in intestinal toxæmia has yet to be established, but the fact that they may not be emptied even by repeated washings out of the gut at once raises the question whether some of the cases of chronic infection may not be the result of absorption from these diverticula, adding yet another source of infection to the already long list. Diverticula, in fact, may be looked upon as miniature appendices that may become chronically and occasionally acutely infected. A term is wanted to describe the condition when diverticula are present without inflammatory changes. The term "diverticulitis" implies inflammation. I suggest the term "colonic diverticulation."

In all suspected cases, or where the examination has revealed nothing abnormal, an examination after twenty-four hours is essential. Diverticula usually occur in the descending portion or sigmoid, although they may be found in any section of the colon and occasionally along its whole length. If there has been any inflammatory condition present (diverticulitis) it is rare for the opaque fluid to get into the particular diverticulum involved, as the opening into the gut is usually occluded. Other patent diverticula are, however, as a rule present, indicating the nature of the case. Residue in the colonic haustra should not be mistaken for diverticula.

Benign Tumours.

These are rare and the radiological differentiation almost impossible. Smooth defects in the outline of the lumen, not characteristic of a malignant tumour, may lead one to suspect the simple nature of the lesion. Polypi will cause a smooth defect if large enough, with little or no obstruction, the shadows cast by the gut in the region being rather mottled in appearance. Multiple adenomata give a similar picture.

Chronic Ulcerative Colitis.

The element of spasm is the main feature here. This leads to a spastic condition of the colon, usually of the descending portion, giving rise to an extensive narrowing of a considerable part of the gut. In rare cases the opaque fluid can be seen adhering to the ulcer surfaces themselves after evacuation. The presence of diverticula may cause symptoms of colitis, and care should be taken not to overlook this condition.

CONCLUSION.

While examination by the opaque enema has been employed for some years, I feel that a more extended use of this method could be made with advantage in this country. But it must be realized that the examination is beset with pitfalls for the unwary.

If careful attention be given to the technical details the method will prove to be rapid and accurate, and to cause minimum discomfort to the patient.

CONCEALED ACCIDENTAL HAEMORRHAGE

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IN addition to the relative rarity of concealed accidental haemorrhage there are several points in the following case of more than passing interest.

On January 1st, 1924, I was asked by her family doctor to see a well developed woman of 26, who was in the thirty-fifth week of her first pregnancy. Down to eighteen hours before I saw her she had enjoyed good health and the urine had been free from albumin. At 10 p.m. on December 31st, 1923, without any apparent cause she was seized with severe cramp-like pain in the epigastrium. An hour later she became faint and complained of a sensation of great fullness in the abdomen. She was carried to bed, and shortly afterwards felt sick and vomited without gaining any relief. Down to the time when I saw her every attempt at ingestion of food or to raise her head resulted in a recurrence of the faintness and vomiting. The bowels had not acted and she was unable to say if she had passed flatus. There was increased frequency of micturition. While the pain had continued without