

the urine has not taken on the characteristics of urine in diabetes mellitus. Therefore, not only does he fill the standards of renal diabetes, but also the clinical course of the case almost surely excludes the diagnosis of diabetes mellitus.

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THE ROENTGEN RAYS IN THE DIAGNOSIS OF GALL-STONES AND CHOLECYSTITIS

AN IMPROVEMENT IN TECHNIC *

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Shortly after the Roentgen rays had proved their value in the diagnosis of urinary calculi, a number of investigators made an effort to demonstrate biliary calculi, and in 1901 I conducted a series of experiments on the cadaver, and repeated them the following year, but discarded the method as being useless and unreliable.

The following difficulties are encountered in the diagnosis of gall-stones:

1. Their density differs little from the surrounding bile, and with this shadow of the bile we must reckon the shadow cast by the liver, which is also more or less saturated with bile. If the gall-bladder contains little bile the stones can be more easily demonstrated. If the biliary calculi are composed partially of calcium salts, they can be then more easily detected. Therefore, the greater the quantity of bile surrounding the gall-stones in the gall-bladder, or the liver, and the less the density, the greater will be this difficulty. Because of less surrounding bile, calculi in the common duct are more easily shown than in a distended gall-bladder.

2. Pure cholesterin stones can sometimes be recognized by their increased transparency as compared with the liver—giving a sort of mottled appearance. Especially is this true when they are covered with a thin deposit of lime. Biliary calculi occur more frequently in stout persons. Therefore, one meets the same difficulties that are involved in examining stout persons with renal calculi. The small shadow cast by the stone must be differentiated from the shadow cast by a great mass of soft tissues. In such cases, not only are we confronted with the density of a great mass of soft tissue, which in itself lessens the differentiation of our shadows, but we must also contend with the secondary radiation from this mass of soft tissue which by its cross-rays tends to obliterate the sharpness of differential shadows.

Therefore, the stouter the patient, the more difficult will be our task, though one must not conclude that the examination is impossible on this account. In a number of cases in which shadows of the calculi were shown the most clearly, the patients were very stout.

3. On account of the faint differentiation of the shadow of a gall-stone, it is necessary to have the liver and gall-bladder absolutely still. This can be accomplished by carefully training the patient to hold the breath, and by applying as much compression as possible.

4. It has been shown by a number of men that overexposure or underexposure, even when the stones are laid on the plate, will nearly obliterate the shadow. A very high or a low vacuum will have the same effect. Therefore the length of the exposure and the degree of

vacuum must be correct. This necessitates a number of plates, made with different time of exposure and different vacuum.

5. One must differentiate the shadow of gall-stone from that cast by calcified costal cartilages, renal calculus and fragments of bismuth, pills or other substances in the stomach or bowel.

In 1910, realizing that our improvements in technic should give us more satisfactory results in the diagnosis of biliary calculi, I renewed my efforts, and in October of that year presented a paper¹ on this subject before the American Roentgen Ray Society.

Since that time a number of investigators have taken up the work. Both Case and myself believe now that about 50 per cent. of gall-stones can be demonstrated, but that negative findings never can be interpreted as indicating the absence of gall-stones.

TECHNIC

1. *Preparation of Patient.*—The patient should be thoroughly purged. For this I prefer a bottle of magnesium citrate. If possible, the stomach should be empty. Therefore, I prefer to give a purgative in the evening and make the examination the next morning before the patient has eaten breakfast. In this way one eliminates the confusing shadows due to gastro-intestinal contents. One also reduces somewhat the total bulk of substance through which the rays must pass.

2. *Position of Patient.*—Having removed all clothing in the line of exposure, I place the patient on the abdomen with the plate under the gall-bladder region. The arms are extended toward the head so that the patient is resting with the chest, elbows and face flat on the table. The upper part of the body is then bent strongly to the left (not rotated). This opens the space between the lower ribs and the crest of the ilium to the widest possible angle, through which the rays can best reach the gall-bladder. Now I generally add a second examination by passing the rays directly through the liver, between the eleventh and twelfth ribs. This position will serve to differentiate foreign substances or concretions in the bowel. I believe this to be an improvement. I have found a third position useful. It consists in taking a board that will support an 8- by 10-inch plate, and with the patient in the position described above, it is placed under the abdomen, with the edge of the board toward the patient's feet. It is made to dip deeply into the abdomen by placing a triangular block under this lower edge. This brings the plate in closer contact with the gall-bladder.

3. *Position of the Tube.*—The tube with the compression-cylinder diaphragm (Albers-Schonberg) is set so that the rays will pass obliquely through the space between the last rib and the crest of the ilium toward the gall-bladder. By means of the diaphragm cylinder we eliminate many of the secondary rays which in the early days made this work impossible. At times a certain amount of compression can be added, which will lessen the total bulk of tissue, and lessen the distance of the tissue and the diaphragm from the plate.

4. *Exposure.*—This should be made as short as possible, and must of necessity be made while the patient is holding the breath. A little time should be spent in training the patient in holding the breath absolutely still. The absolute time cannot be set, for it will depend on the power of the apparatus, and on the skill of the

* Read before the Philadelphia County Medical Society in a symposium on gall-bladder disease, March 11, 1914.

1. Pfahler, G. E.: *Am. Quart. Roentgenol.*, April, 1911.

operator, who must judge quickly at the time, according to the working of the tube. I agree with Rubaschaw² that several exposures are generally necessary with different tubes and different times.

5. *Vacuum of the Tube.*—This should be the same as that used in making kidney examinations, and should register from Nos. 6 to 7 on the Benoist scale.

6. *Improvement in Technic for the Demonstration of Less Opaque Calculi, the Outline of the Gall-Bladder and the Under Surface of the Liver.*—Inflation of the Colon and Stomach: After making the preceding investigation one will sometimes be able to demonstrate cholesterol stones and those containing a very minute quantity of calcium salts, which would otherwise be overlooked, by inflating the colon with air. Case suggested this for the demonstration of the lower border of the liver. For this purpose I use a moderate-sized rectal tube, and attach to it an atomizer bulb. With the patient on the fluoroscopic table I then gradually dilate the colon with air, watching the effect until the patient complains of some discomfort and until the lower border of the liver is well outlined. I then make some plates of the lower border of the liver in this position. With a screen directly over the liver, and with a small diaphragm, I watch until the gall-bladder is outlined. One or more plates are then made in this position. The patient is then placed in the vertical posture, which permits the gas to rise more definitely to the upper portion of the colon, and in this way outline the lower border of the liver more fully. When this procedure is not sufficient, or when the left lobe of the liver is under special consideration, air is pumped into the stomach by means of a stomach-tube, or the stomach is distended by means of a Seidlitz powder.

When it is necessary to study the stomach and colon by the bismuth method following this examination, the patient should be placed back on the fluoroscopic table, and the air expelled from the colon through the rectal tube. If this is not done the excess of gas in the colon will distort the stomach and interfere materially with the examination. All of these procedures must, of course, be modified to suit the particular portion of the stomach, or bowel, that is under examination. I find it very difficult to establish any routine method of examination. The technic must be modified in each case according to the probabilities of the diagnosis. After eliminating the air from the colon it can then be injected by the opaque solution, and the bowel studied regularly. It is sometimes difficult to eliminate all the air from the colon, and when obstruction or constriction of the bowel is under serious consideration, it should not be injected for preliminary study. This injection of the colon also interferes with the evidence of adhesions about the duodenum. One must therefore decide what evidence can be sacrificed best.

General Procedure: In general, I make a plate of the right kidney, then turn the patient on the abdomen in Position 1, and make two or more plates; then place the tube over the liver and make another plate in Position 2; then one in Position 3. I then inject the colon and make several plates.

Renal Calculus.—In one patient who had the symptoms of gall-bladder disease, I found a stone in the upper part of the right kidney. This can be determined usually by using the customary technic for a kidney examination, when the shadow of the stone will be more distinct and smaller.

Calcareous Deposits.—In the costal cartilages calcareous deposits are liable to occur in streaks, to be found on both sides and not to be confined to the region of the gall-bladder. There is, of course, nothing to prevent the occurrence of both gall-stones and calcifications in the costal cartilages in conjunction. In such instances the absolute differentiation is almost impossible.

The possibility of artefacts will occur to every experienced roentgenologist; but this can be eliminated by a repetition of the examination, and by multiple exposures on different plates.

Pericholecystitis.—In the diagnosis of cholecystitis by means of the Roentgen rays, the evidence obtained is less direct. One may find an enlarged gall-bladder at times without special technic, during the course of a general gastro-intestinal examination. This is recognized by the displacement of gas in the colon (there is usually some gas present in the hepatic flexure in the upright position), or by displacement of the bismuth content in the duodenum or colon. The enlarged gall-bladder can be demonstrated further by the injection of the colon with air.

Pericholecystitis is liable to be followed by or associated with adhesions to the duodenum or colon. By inference when adhesions of the duodenum are found this may indicate a preceding or associated cholecystitis. The interpretation of adhesions in the gall-bladder region must be made with great care. When in a relaxed, thin abdomen one finds the duodenum drawn up and to the right, to the under surface of the liver, moving upward with the diaphragm or liver, and occupying a relatively abnormally high position with relation to the normal attachments, one has little difficulty in deciding that adhesions are present. This is especially true when there is associated evidence in these cases of adhesions about the hepatic flexure, and when there is associated deformity in the outline of the duodenum; but when these conditions are not all present, and when one is dealing with a patient who is well nourished or even at times fat, the recognition and demonstration of adhesions is difficult, and should be interpreted with the greatest care, for a fat abdomen naturally holds the stomach high and crowds the stomach and duodenum up close to the liver. Sometimes one can hold a stomach down in such cases, and determine whether or not, during the forced expiration, the duodenum moves disproportionately upward with the liver.

In an effort to determine as nearly as possible the value of the Roentgen rays in the special studies of the gall-bladder, I have tried to trace the various cases that have been studied. I have received reports concerning fifty patients. Of these, seventeen have not yet been operated on, and therefore must be eliminated from our conclusions. Thirty-three have been operated on. Of this number stones were found by me in twenty. Stones were found by the surgeon in twenty-seven. The probability of stones was diagnosed in two others, which were not found. A probable diagnosis of stones was made in seventeen other cases, in which the patients have not yet been operated on, but in which the evidence obtained was strong enough to be reduced to lantern-slides. In all, twenty-seven patients had gall-stones removed by the surgeon. Of this number, twenty, or 74 per cent., were demonstrated by the Roentgen rays. I believe that this percentage is high, and that in general not more than 50 per cent. can be shown, unless, perhaps, by the improved technic described, which has been employed only in recent cases.

2. Rubaschaw: Fortschr. a. d. Geb. d. Roentgenstrahl., xxi, 533.

My percentage of positive findings is unusually high, probably because I have been making the effort to find the gall-stones. Contrary to Case³ and Cole,⁴ I do not expect to find the gall-stones during a bismuth study of the gastro-intestinal tract, but make a direct preliminary study for gall-stones by the special technic which I have described, and then follow with the bismuth study. In only one of the thirty-four cases in which I have found evidence of gall-stones did I find the stones during the bismuth study of the gastro-intestinal tract, and in that case the stones were so dense that no one could overlook them. Stones containing a high percentage of lime-salts can of course be demonstrated in this way, but in most of my cases the stones contained very little lime-salts, and could be seen only on a very clear plate by careful oblique illumination.

Likewise for the demonstration of these light stones, screens, as recommended by Cole, are unreliable. In nearly all cases I used screened and unscreened plates, and rarely was able to recognize the stones on the intensified screen plates.

CONCLUSIONS

1. Gall-stones can be shown only when they are composed of a substance of greater or less density than the surrounding tissues. This will usually mean that they must contain some lime-salts, though this quantity may be small.

2. My records show positive findings in 74 per cent., but I believe in general one cannot count on more than 50 per cent. being demonstrable. I believe that a negative diagnosis at present has no value.

3. It is possible that with the improved technic, when we find the gall-bladder small, and still find no stone, it may become of some value in negative diagnosis.

4. The estimation of the value of this method of diagnosis must be based only on the work of roentgenologists who have mastered a good technic, and who are thorough in their work.

5. Definite information will be obtained only by continued cooperation of the surgeon and the roentgenologist.

6. In the future I believe that we shall obtain valuable information concerning the liver and spleen by the roentgen method described.

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THE ABSORPTION AND TENSILE STRENGTH OF CERTAIN ABSORBABLE ANIMAL LIGATURES

A PRELIMINARY REPORT

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While much laboratory work has been done on the standardization of various therapeutic agents, before their introduction into the human organism, suture materials have, up to the present, been neglected. Too often the poor quality and careless preparation of catgut have been discovered only by its postoperative ill effects, whereas previous experiment might have averted such accidents.

This report is the result of 119 implantations, in animals, of various sizes and preparations of catgut and

kangaroo tendon. The animals used to yield the final standardization results were robust Belgian hares and small healthy dogs. It was noticed, that in a few of the animals which became infected with a disease characterized by a nasal catarrh and emaciation, the absorption period of the ligatures was much delayed. This may be the reason why in some patients the absorption time has been exceeded and may be due to a decrease in metabolic processes dependent on a lowered vitality.

In five of the cases in which the dressings were purposely not applied to the experimental incisions a staphylococcus infection was noted. In these cases the absorption of the ligatures was much delayed and sutures removed from the wounds were found covered by a cheesy exudate consisting of dead leukocytes, fibrin and detritus, which could be scraped from the attenuated suture, but which formed a coating sufficiently dense to prohibit the free access of tissue fluids and cells.

The catgut standardized so far has been prepared by the cumol method of Krönig, and has been compared with catgut prepared by different manufacturers using the same method, and also with catgut prepared by the liquid petrolatum and iodine method of Bartlett. Although catgut prepared by the latter process has less tensile strength and may not be heated, it otherwise has about the same properties as catgut sterilized by the cumol method.

TABLE 1.—ABSORPTION PERIOD

Nature of Material	Tissue of Implantation	Absorption Period
Plain Catgut—		Days
Size 00	Human prepucce (circumcision).....	7
0	Muscle	11
0	Fascia	10
1	Muscle	13
2	Muscle	16
3	Muscle	21
Chromic Catgut "20-day"—		
1	Peritoneum	18
1	Muscle	22
1	Fascia	20
2	Muscle	20
3	Fascia	20
Kangaroo Tendon—		
Fine	Peritoneum	30
Fine	Fascia	30
Medium	Fascia	38

An important yet simple process, which, in the manufacture of chromic catgut, is frequently omitted or done in a careless manner, is the neutralization of the potassium bichromate in the catgut after the chromicizing bath. If this neutralization is not carefully carried out, the formation of a sinus extending outward from the offending suture often results, adding five or ten days to convalescence and sometimes interfering seriously with the proper healing of the wound.

From certain of the animals the suture materials were removed at various periods before absorption was complete, and then were tested as to their tensile strength. This has been done in only a few cases, and the series is not yet complete.

In the case of kangaroo tendon it was found that the period of absorption as usually stated is too long. Some of the tendons had disappeared by the thirtieth day, except in a few cases in which the tendon was attenuated to very thin strands, the size of fine hairs.

A rather unexpected result was the slightly more rapid disappearance of sutures from fascia than from muscle. If both specimens were unabsorbed there was invariably more attenuation of the catgut implanted in the fascia, and in cases in which the suture had disappeared from the fascia, small strands were found in the muscle.

3. Case: Arch. Roentgen Rays, September, 1913, 135.

4. Cole: Surg. Gynec. and Obst., February, 1913.