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The Detection of Pure Cholesterine Gall-Stones by the Roentgen Rays

By DR. LEWIS GREGORY COLE, New York City

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THE DETECTION OF PURE CHOLESTERINE GALL-STONES BY THE ROENTGEN RAYS

By DR. LEWIS GREGORY COLE, New York City

It is "safe and sane" to make a positive diagnosis of gall-stones when they are composed of calcium, or have such a definite calcareous coating or nucleus that they show as distinctly as those illustrated below.

Fig. No. 1 represents sections from real roentgenograms of the living subjects.

Stones like these have occasionally been detected roentgenographically since the rays were first discovered, but were found so infrequently that no systematic attempt was made to show them until three or four years ago.

The demonstration of a group of indistinct gall-stones by George at the last American Roentgen Ray Society meeting, stimulated me to an unusual effort in this line of diagnosis. A careful study of radio-

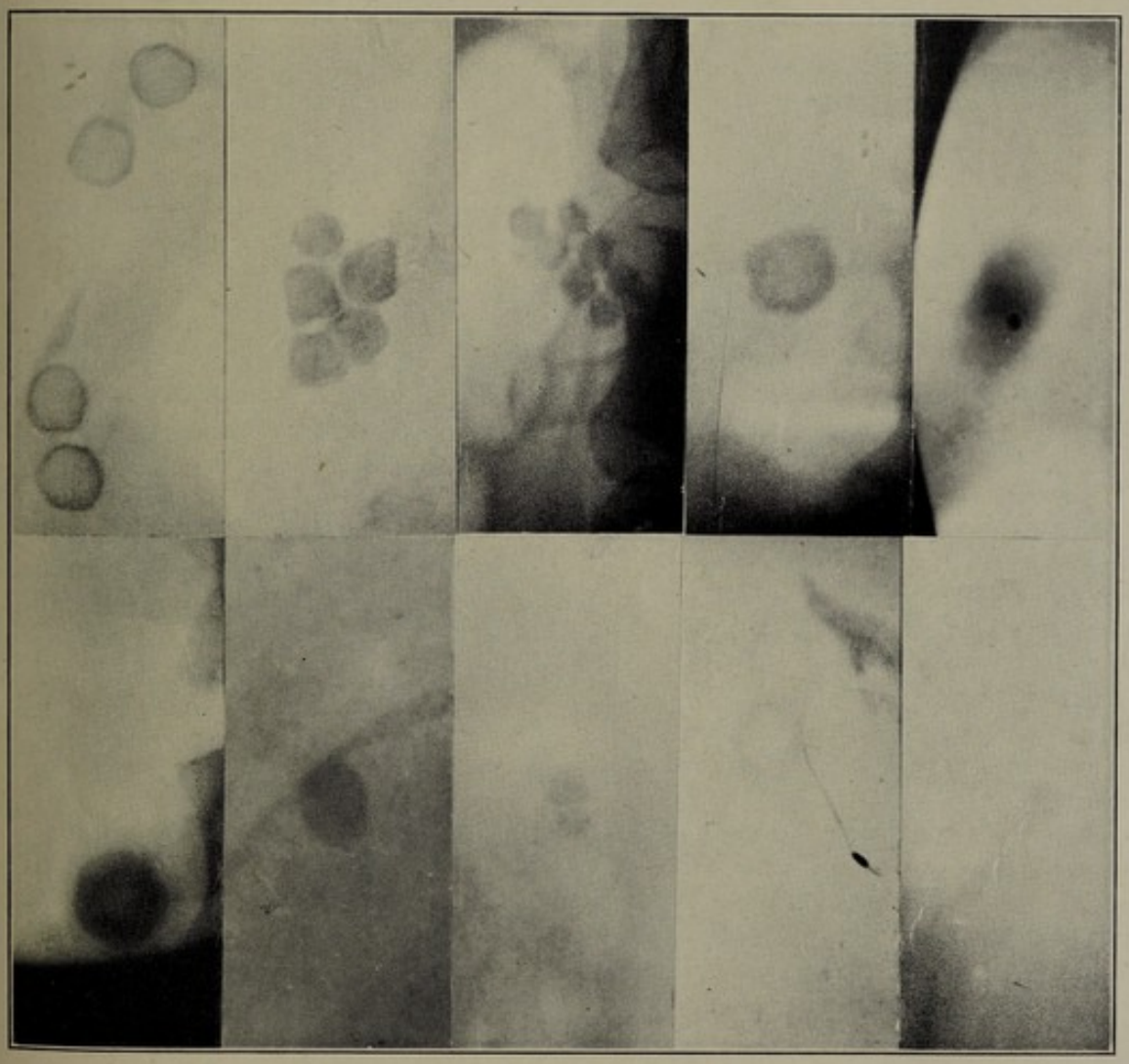

FIGURE 1.

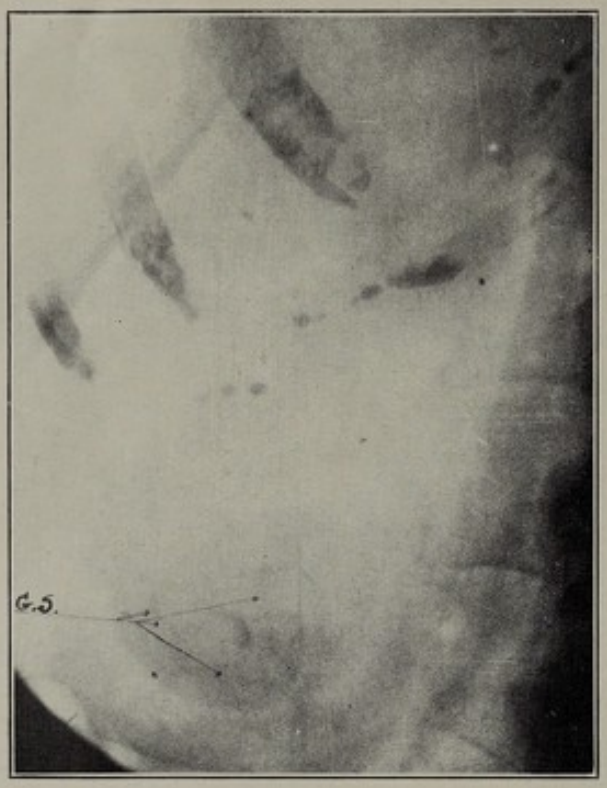

FIGURE 2A.

grams made by the technique described in the previous communication* by George and Cole, enabled us to detect gall-stones in a far greater number of cases than had been supposed possible, although with the additional detail in the roentgenograms there were added difficulties in the interpretation of the findings.

Gall-stones from seventy-five cases were placed at my disposal through the courtesy of Dr. John Erdman. A study of thirty of these taken at random, together with a few freshly removed stones, forms the basis of the present communication.

Immediately before this investigation I had been fortunate enough to obtain a roentgenogram of a dilated gall-bladder in a case that had been referred to me for a kidney examination. After a careful study of radiograms of the gall-bladder region I made a diagnosis of an unusually dilated gall-bladder probably containing calculi. But it was not until several days later while

* The Negative and Positive Diagnosis of Gall-stones by Improved Roentgenological Methods. Cole and George. Boston Med. and Surg. Jour., March 4, 1915.

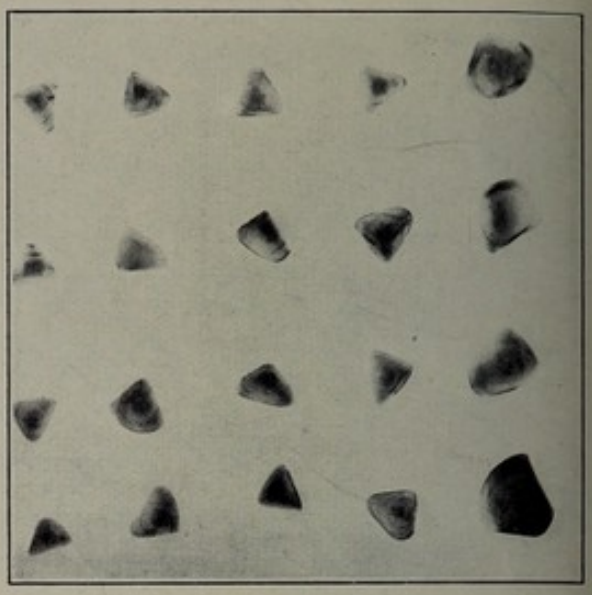

FIGURE 2B.

I was examining the plate with George that he called my attention to the characteristic markings in the gall-bladder region.

Fig. 2A is a reproduction of the roentgenogram showing the stones in situ.

Fig. 2B is a roentgenogram showing a few of the most distinct stones after removal, surrounded by air.

Fig. 2C is a roentgenogram showing some stones submerged in water.

These stones show a slight trace of calcium coating but they certainly could not be included in the "safe and sane" class of gall-stones.

From these, one characteristic calculus, which will be designated as the "Key-stone" was selected as a standard of comparison, and the whole value of this investi-

FIGURE 2C.

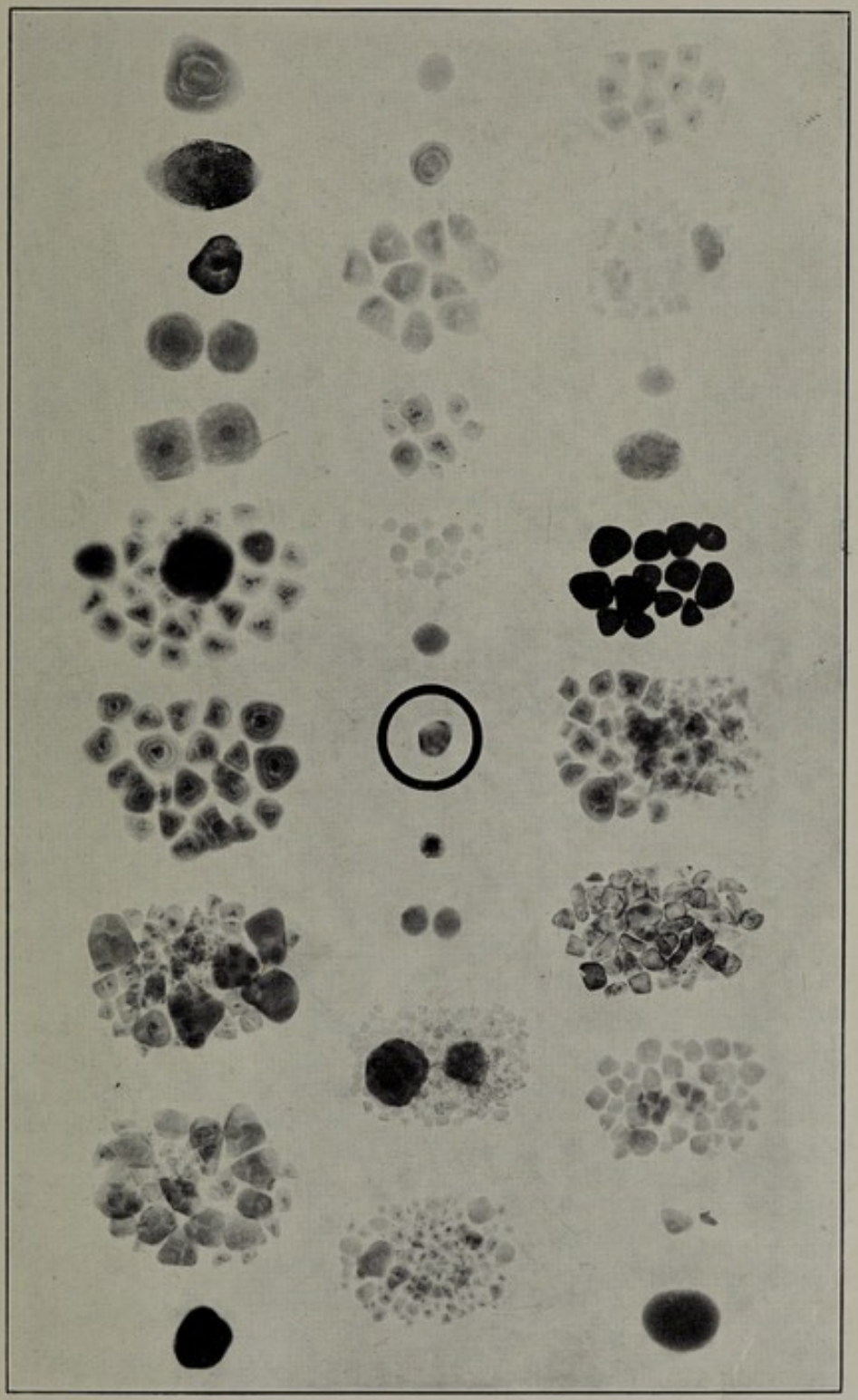

FIGURE 3.

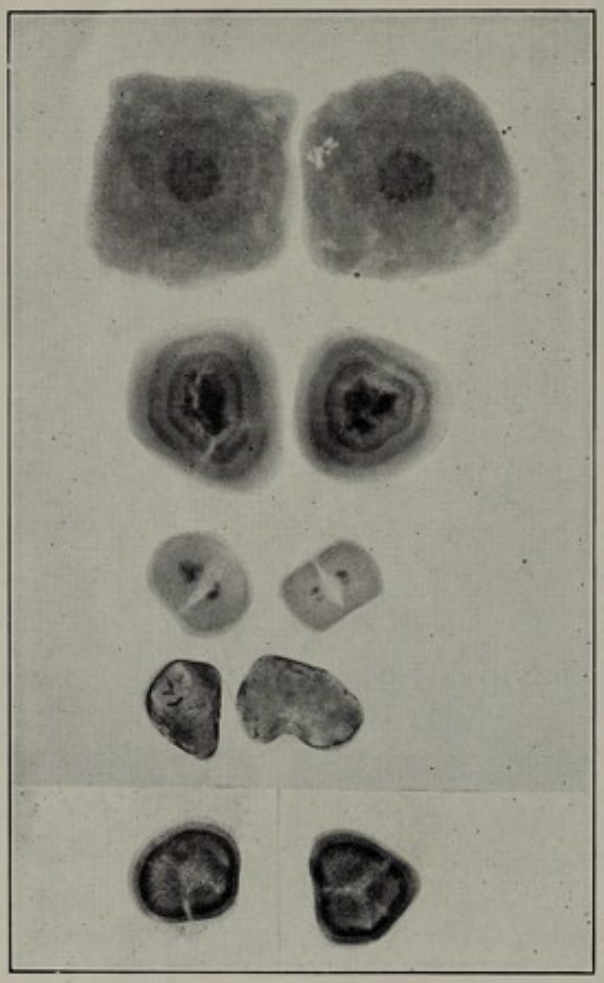

FIGURE 4.

gation depends on the comparing of the density of stones of every case with this stone which we knew could barely be shown in the living subject.

In the first test, stones from each case were placed on a plate and an exposure made. (Fig. No. 3.)

The "Key-stone" is in the center within the ring. The remarkable similarity in the distribution of the calcium in all the stones of the same case is worthy of note. That is, if one of the stones has a calcareous nucleus all of that case do, or if a stone has a calcareous coating the other stones of the same case have it also.

Two stones each from five different cases magnified to show the distribution of the calcareous deposit will illustrate this. (Fig. No. 4.) The calcareous deposit indicates the various periods of growth of the stone in the same manner that strata in the earth indicate different geological periods.

A study of such calcareous deposits, interspersed with specimens of the cholesterine deposit, compared with a perfect clinical history might be of great interest and perhaps throw some light on the cause and growth of gall-stones.

Fig. No. 5 illustrates graphically the small percentage of stones that have a sufficient calcium deposit to show like those in Fig. 1. Twenty per cent of the stones had a calcareous deposit in the form of a coating or a nucleus which rendered them more dense to the roentgen rays than the "Key-stone." These were arranged on the top line. The "Key-stone" was placed on a line

FIGURE 5.

FIGURE 6.

by itself. Twenty-four per cent of the stones had a trace of calcium but less than the "Key-stone." Fifty-six per cent showed practically no calcareous deposit. These were arranged on the bottom line.

The same stones were then submerged in bile contained in a thin paper box, but as some sank and others floated they could not be arranged in the same order as in the previous plate. (Fig. No. 6.)

The six stones containing as much or more calcium than the "Key-stone" were of greater density to the X-Ray than the surrounding bile, and the sixteen stones that had practically no calcium gave a negative shadow, or less of a shadow than the bile in which they were submerged. This observation at first seemed to preclude the hope of a positive diagnosis in more than about twenty-five per cent of the cases of gall-stones.

It was suggested that as these stones had been removed for some time they might have dried out. To meet this criticism, we succeeded in obtaining several fresh specimens of gall-bladder containing stones and bile, and these were radiographed within two hours of their removal. They were placed beside the "Key-stone" and a roentgenogram was made; but this showed the gall-bladder compared with air and therefore to demonstrate the density of gall-bladder and gall-stones as compared with water which has about the same density as the human flesh the gall-bladder and the "Key-stone" were submerged in distilled water in a paraffin-lined paper box, and a roentgenogram was made.

The experiments on fresh gall-bladder specimens containing stones were sufficiently important to report in detail.

SPECIMEN No. I., from Dr. Erdman was of great importance, and a study of the illustrations of this specimen will demonstrate more graphically than words can describe how pure cholesterine stones surrounded by bile and contained in a gall-bladder will give the ring-like shadows so characteristic of gall-stones.

A roentgenogram of one hundred fifteen gall-stones laid out on a plate showed that there is not a trace of calcium in any of these stones and it should be particularly noted that there is no calcareous coating or ring. (Fig. No. 7A.)

The same stones submerged in bile show less distinctly than the bile surrounding them. That is, they cast a negative shadow. (Fig. No. 7B.)

The stones are now pushed together; the bile surrounding each stone appears as a ring and the bile itself has a "honey-comb" appearance. (Fig. No. 7C.)

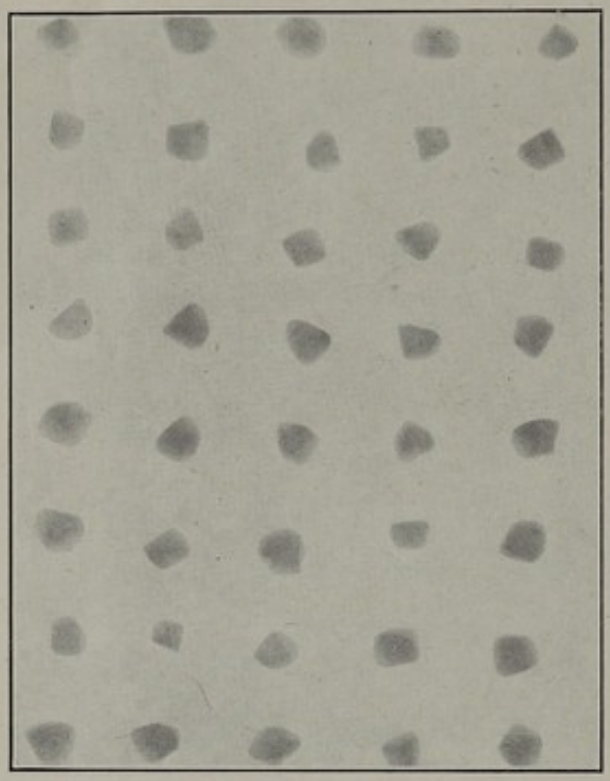

FIGURE 7A.

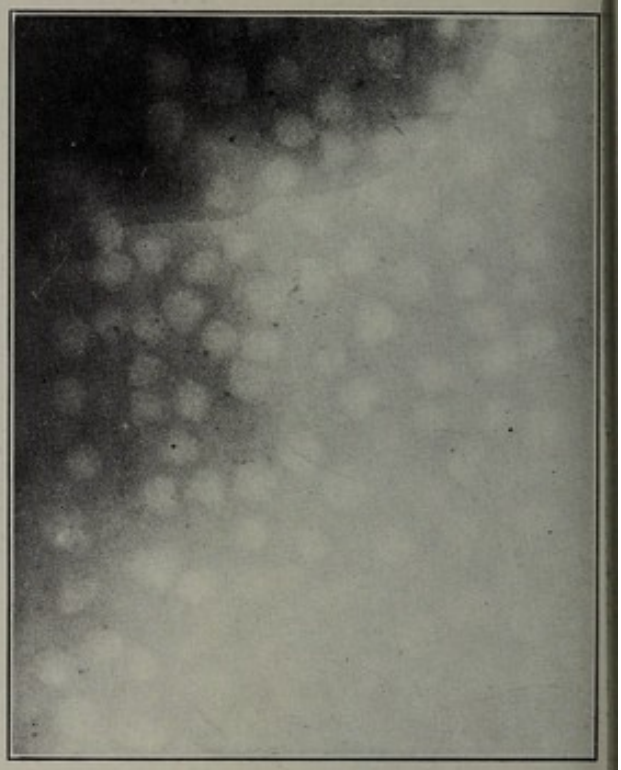

FIGURE 7B.

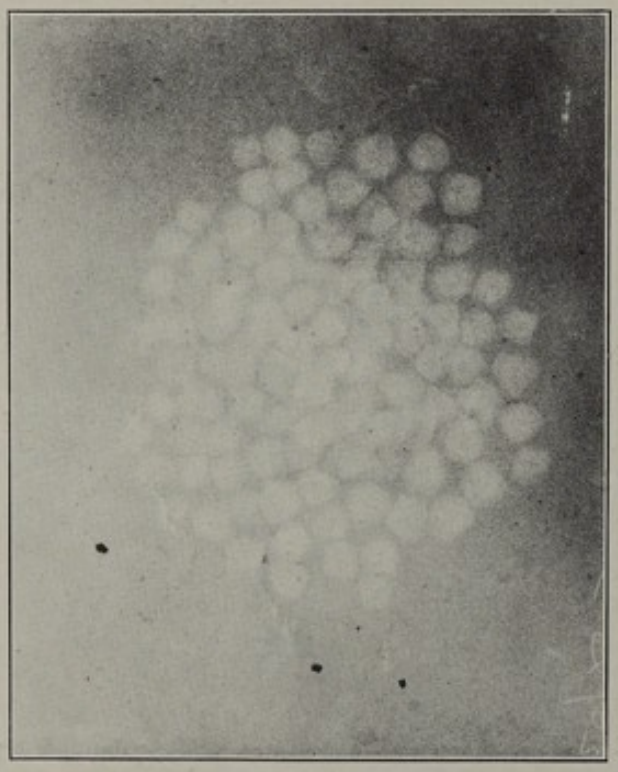

FIGURE 7C.

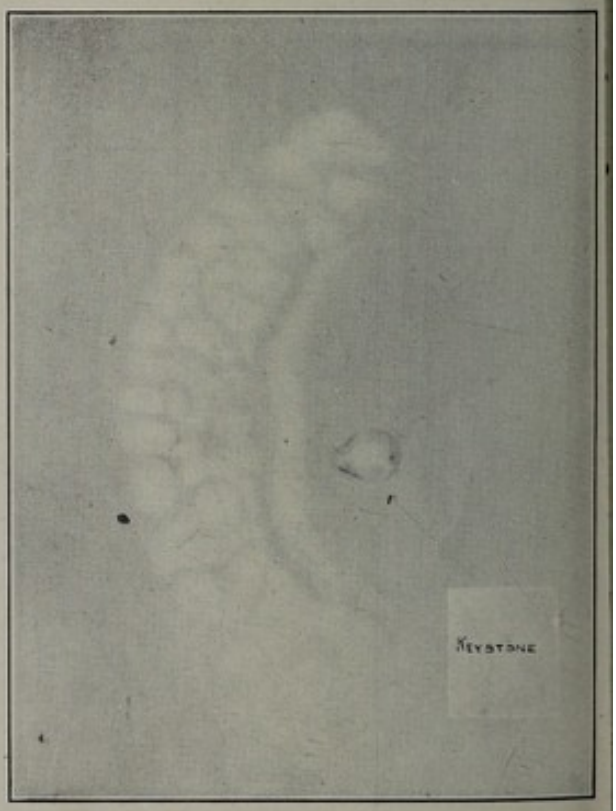

FIGURE 7D.

One more step. A gall-bladder containing stones surrounded by bile is submerged in water. The bile surrounding the stones presents a typical ring-like appearance and the stones are confined to an area the size and shape of the gall-bladder, but it must be remembered that there are no calcareous coatings to these cholesterine calculi, and that the ring-like appearance is caused by the surrounding bile. (Fig. No. 7D.)

SPECIMEN No. II., from Dr. Erdman was a normal sized gall-bladder containing bile and three stones.

(Fig. No. 8A.) Stones showing no evidence of calcareous deposit.

(Fig. No. 8B.) Stones submerged in bile and giving a negative shadow.

(Fig. No. 8C.) Gall-bladder and gall-stones submerged in water compared with the "Key-stone." Stones and bile are seen in the gall-bladder, but the stones are separated from each other by so much bile that they appear as bubbles of air or gas in the gall-bladder. Therefore, one or two large cholesterine stones in a gall-bladder filled with bile will resemble a bubble of gas in the intestines except that the gall-stones when seen are always constant in size and shape.

SPECIMEN No. III., from Dr. Erdman was an elongated and dilated gall-bladder filled with stones and bile.

Each stone has a small calcareous nucleus; this is hardly dense enough to show as positive shadow. (Fig. No. 9A.)

(Fig. No. 9B.) The stones are submerged in bile. It is noted that the calcareous deposit renders them nearer the density of the surrounding bile; therefore, they do not show a negative shadow so distinctly as the pure cholesterine stone does.

(Fig. No. 9C.) The gall-bladder filled with stones and bile and submerged in water compared with the "Key-stone." It is evident that this combination of a nucleus of calcium surrounded by a cholesterine coating is the most difficult to show but even this type can probably be detected in many cases by a careful examination.

These tests emphasized the astonishing fact that the cholesterine stone, unless it contained calcium, was so much less dense

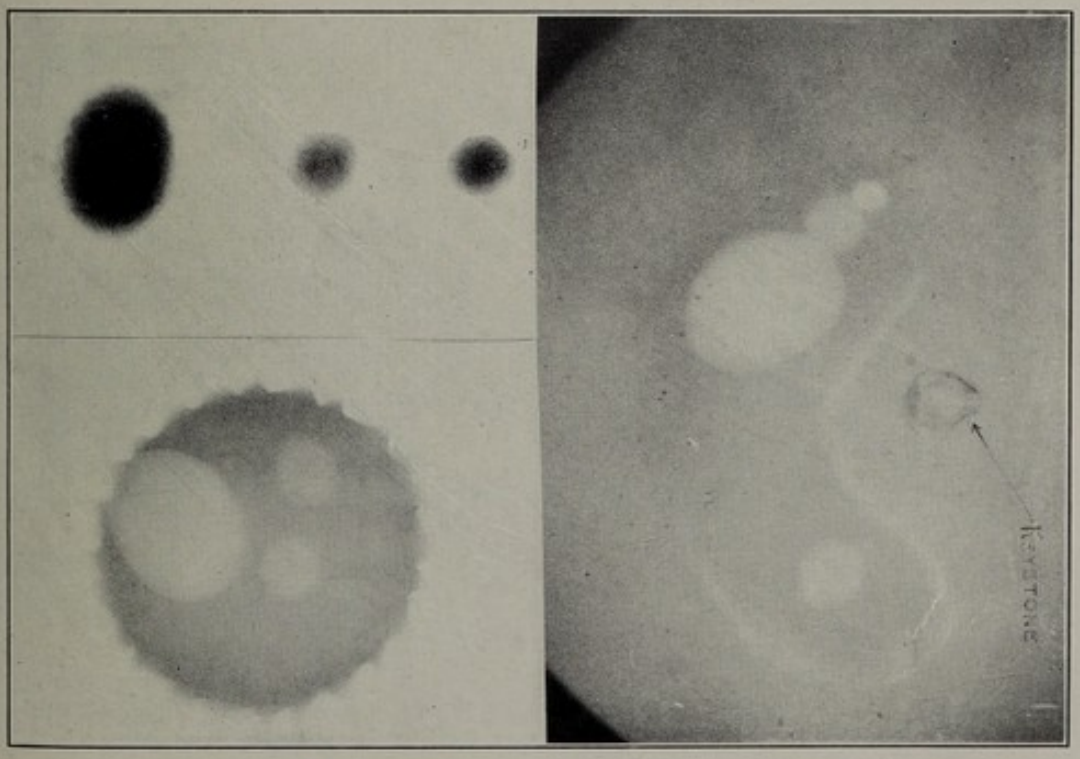

FIGURE 8A.
FIGURE 8B.

FIGURE 8C.

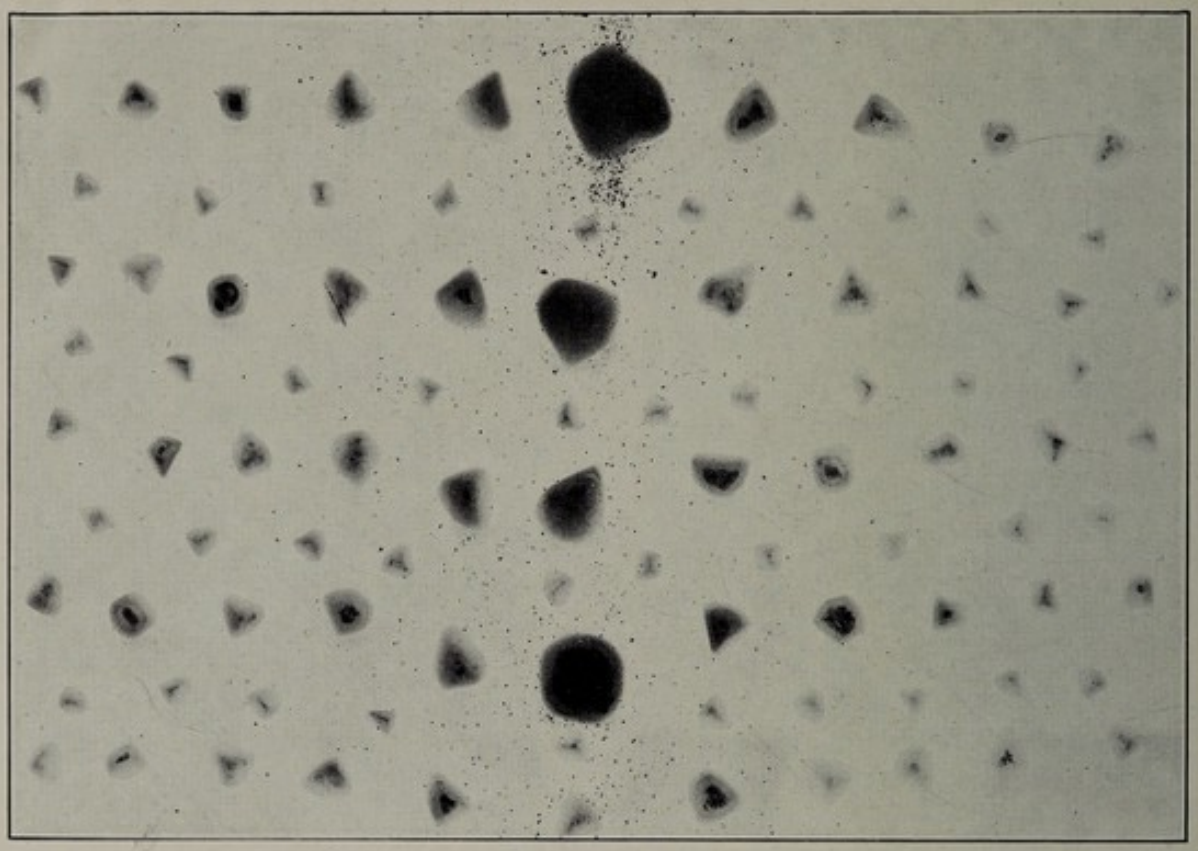

FIGURE 9A.

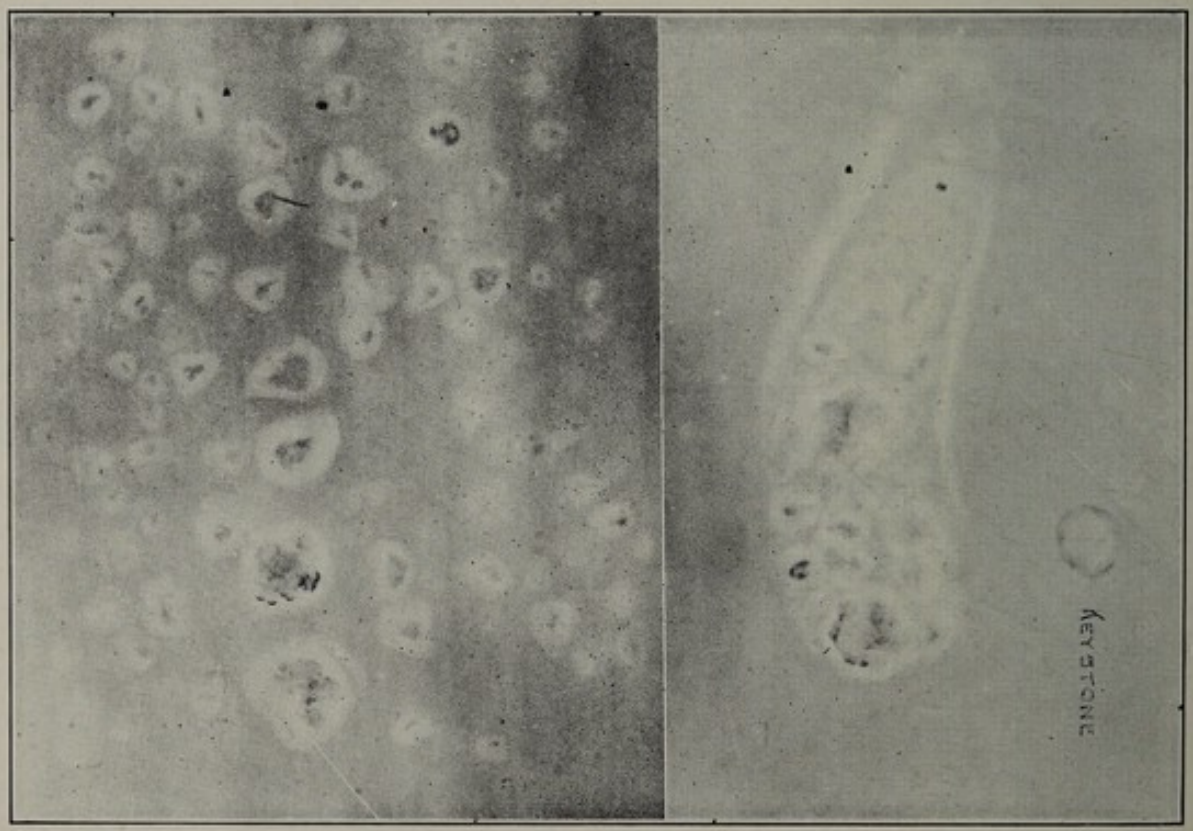

FIGURE 9B.

FIGURE 9C.

than the bile by which it was surrounded that it cast a negative shadow; that is, in the original roentgenograms the stone looked black like gas in the intestines instead of white like a kidney stone. This observation revived the hope that even the pure cholesterine gall-stone could be detected by the direct method of X-Ray examination.

The practical application of this experimental work is shown in the following case which has been examined three times within the past year, and which will be described in detail. The case came to operation and the dilated and thickened gall-bladder containing the stones is reproduced here and furnishes the connecting link between the experiments and their application.

Clinical History: A woman, aged 55, with an atypical history of gall-bladder disease.

Roentgen Findings: Roentgen examination of the gall-bladder on three different occasions during the last year showed a dilated and dense gall-bladder at each examination.

Roentgen Diagnosis: The following is a quotation from the roentgen report: "There is evidence of a dilated gall-bladder which is slightly irregular in shape and apparently has a small constriction at its upper end. The irregularities in the density of this dilated gall-bladder justify me in stating that there is seventy-five to eighty per cent chance of there being gall-stones in this gall-bladder."

Surgical Findings: A dilated and greatly thickened gall-bladder containing several gall-stones. (Fig. No. 10A.)

Roentgenograms of the removed gall-bladder containing the stones surrounded by bile showed that the stones cast a negative shadow, that is, were less dense than the surrounding bile. This was accentuated when the gall-bladder containing the bile and stones was submerged in water. (Fig. No. 10B.)

Twenty-four hours after removal, decomposition caused the accumulation of gas in the gall-bladder. Roentgenograms taken then of the gall-bladder and stones in the air (Fig. No. 10C) and submerged in water (Fig. No. 10D) show very plainly the marked resemblance between the stones and bubbles of air or gas.

Many men will say that they care nothing for gall-stones in bottles, or gall-stones laid out on the plate, or submerged in water or in bile even if they are in the gall-bladder and examined immediately after its removal. Nor are they of value, except as a proof of the manner in which pure cholesterine stones in a gall-bladder filled with bile cast characteristic ring-like shadows.

"One swallow does not make a summer," but it indicates that spring is coming and as proof that these experiments have not been fruitless, I wish to describe briefly my failures and successes during the last four months.

I have made a definite or probable diagnosis of gall-stones in thirty cases. In only one case was there the amount of calcareous deposit which, six months ago, I deemed necessary to justify one in making a safe diagnosis of gall-stones.

Sixteen out of thirty have been operated upon. Of these sixteen cases, twelve were correctly diagnosed roentgenographically, three incorrectly diagnosed, and one very provisional diagnosis was incorrect.

In two of the three cases in which an erroneous roentgen diagnosis was made the real lesion would have been detected if a complete gastro-intestinal examination had been made instead of limiting ourselves to the experimental diagnostic feat of attempting to diagnose the case solely by detection of direct evidence of shadows of either greater or less density than the surrounding shadows. But these errors have been of greater value than the correct diagnosis. One was due to food in the cap (Fig. 11). Another was due to feces in a haustrum of the colon and the third was due to the stomach being crowded up and to the right by abdominal fat in a manner very char-

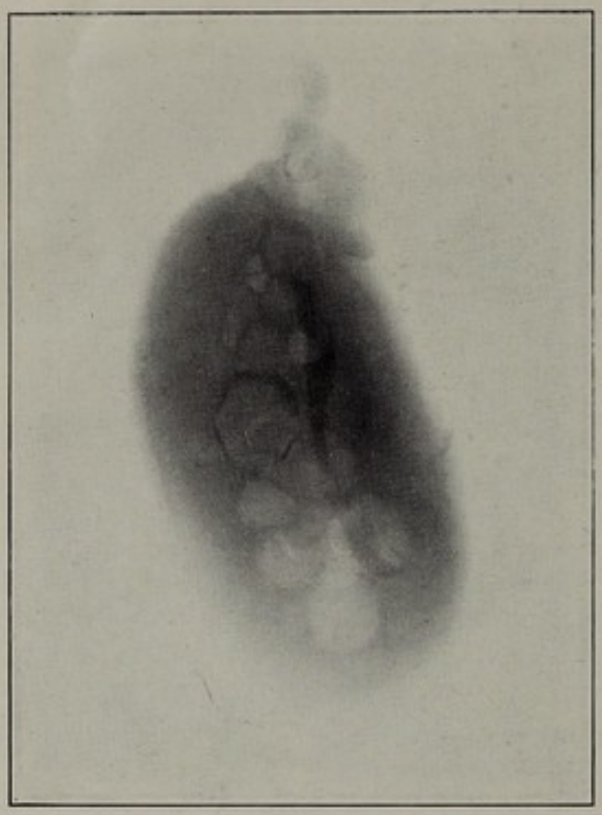

FIGURE 10A.

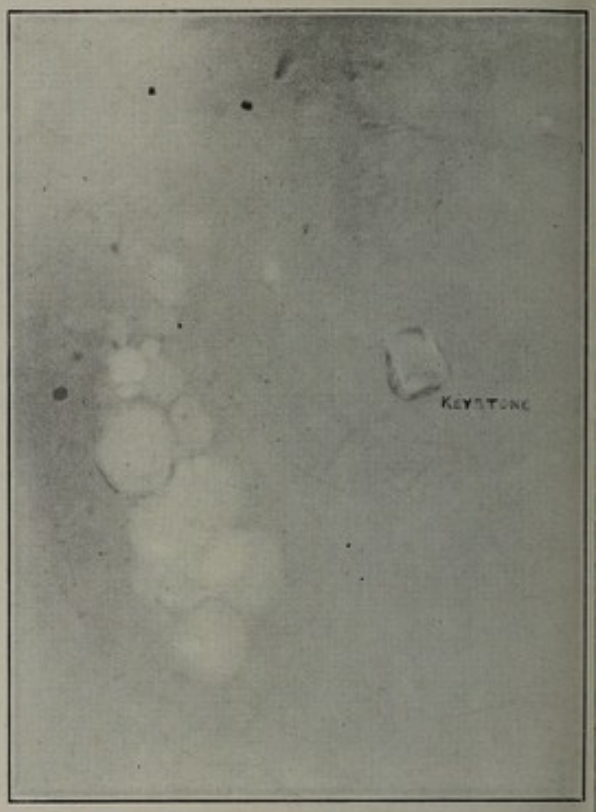

FIGURE 10B.

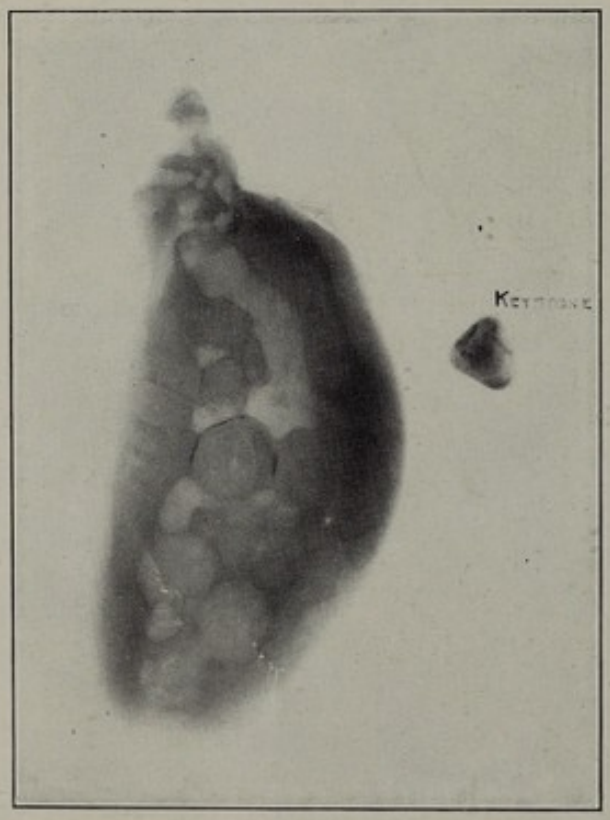

FIGURE 10C.

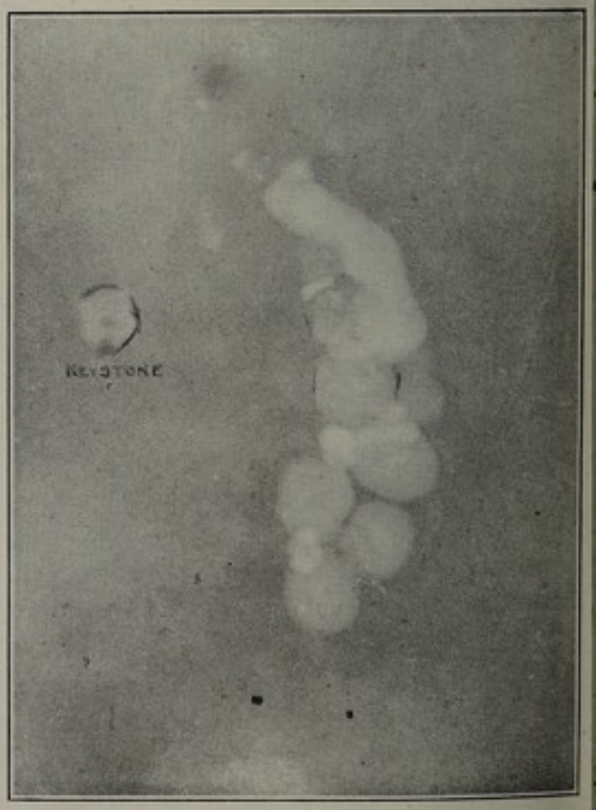

FIGURE 10 D.

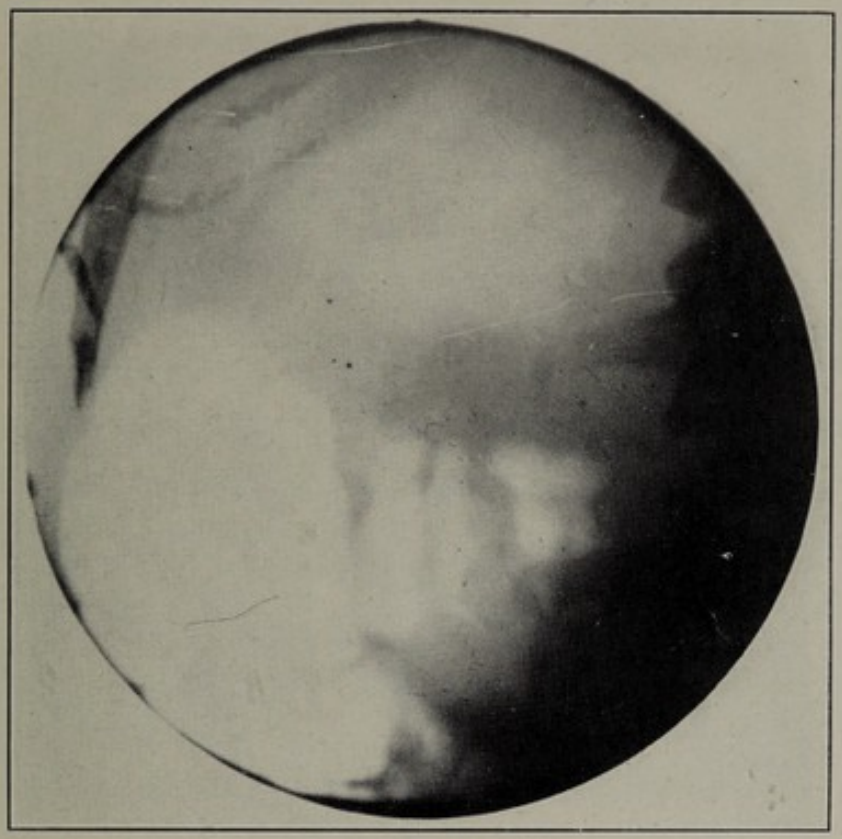

FIGURE 11.

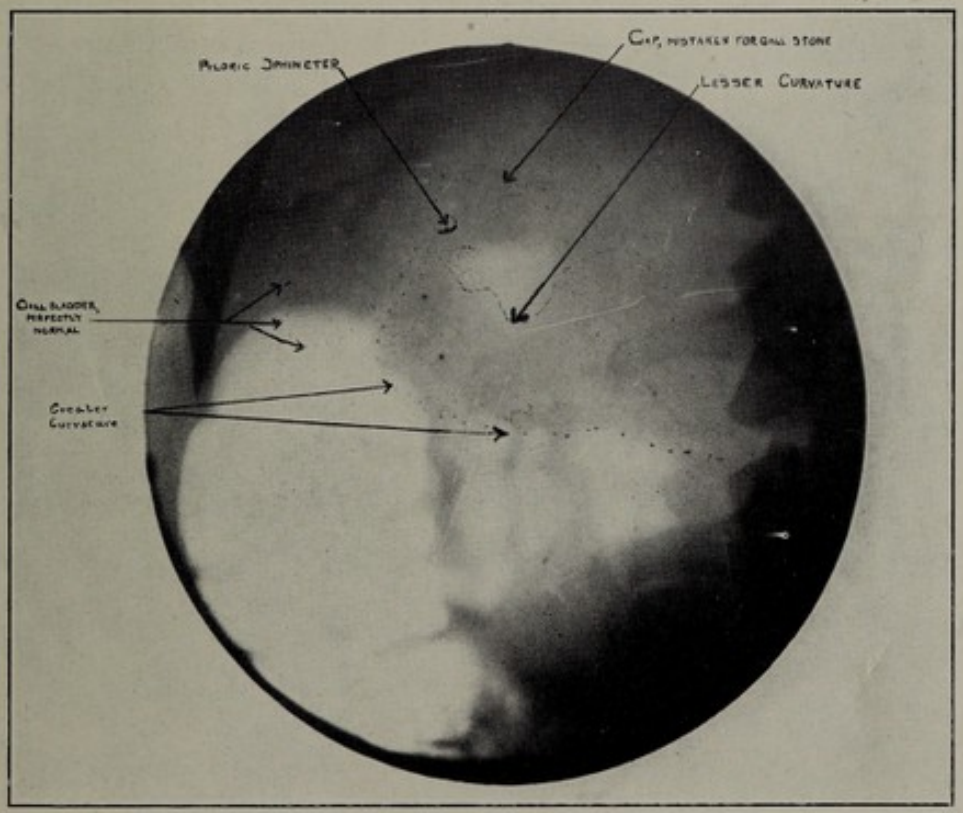

FIGURE 11B.

acteristic of gall-bladder adhesions. In this case the diagnosis was based on indirect evidence.

RESUMÉ

It is "safe and sane" to make a positive diagnosis of gall-stones when they have a definite calcium coating or nucleus.

Stones from thirty cases were examined by radiography; plates were also made of them surrounded by air, and later submerged in bile.

A gall-stone which had just enough calcium deposit to show in the living subject was selected as a basis of comparison for the stones from the thirty cases. This was called the "Key-stone." About twenty per cent of the gall-stones showed more calcium deposit than the "Key-stone." About twenty-six per cent showed a trace of calcium but less than the "Key-stone." About fifty-four per cent showed practically no calcareous deposit; in other words, they were practically pure cholesterine.

The alternating calcareous cholesterine rings indicate periods in the growth of the stones as strata of the earth's surface indicate geologic periods.

Eighty per cent of gall-stones submerged in bile cast a shadow less dense than the bile surrounding them. This observation would seem to preclude the hope of a positive diagnosis of gall-stones in more than twenty or twenty-five per cent of the cases. But the cholesterine stones are so much less dense than the bile surrounding them that they appear like bubbles of air and when many stones are present the bile surrounding them appears more dense than the stones and gives the area of the gall-bladder a honey-comb appearance or the ring-like shadows typical of a group of gall-stones.

This is graphically shown where stones are roentgenographed, First, in the air; Second, floating in bile; Third, grouped close together in bile; Fourth, surrounded by bile in a gall-bladder submerged in water.

These tests show that even the pure cholesterine stone may be shown as a negative shadow and that when a number of them are packed into a gall-bladder the bile surrounding the stones gives them ring-like shadows.

These preliminary tests have been applied practically during the last four months and the failures and successes of a series of sixteen cases that have been operated upon are briefly reported in this communication.