The Röntgenologic diagnosis of surgical lesions of the stomach and duodenum / by George Emerson Brewer, M.D. and Lewis Gregory Cole, M.D. of New York City.

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With the Collaboration of

J. WILLIAM WHITE, Ph.D., M.D., of Philadelphia; SIR WILLIAM MACEWEN, M.D., LL.D., of Glasgow;

W. H. A. JACOBSON, M.Ch., of London.

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By George Emerson Brewer, M.D.

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Lewis Gregory Cole, M.D.

of New York City

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THE RÖNTGENOLOGIC DIAGNOSIS OF SURGICAL LESIONS OF THE STOMACH AND DUODENUM*

By George Emerson Brewer, M.D.

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Lewis Gregory Cole, M.D.

of New York City

The object of this communication is to report a series of cases furnishing data which may help to solve two important questions:

First, is there reason to believe from our present experience that the Röntgen ray will eventually prove as valuable for the diagnosis of surgical lesions of the stomach and duodenum as for the diagnosis of fractures and urinary calculi?

Second, what method of Röntgen examination gives the most accurate results? In the first question it will be noted that we have used for comparison only the diagnosis of fractures and urinary calculi. While röntgenology has proved of great assistance in the solution of many diagnostic problems, such as joint and bone diseases, pulmonary tuberculosis, aneurisms, sinus infections, etc., the surgeon accepts the röntgenographic evidence of fractures and renal and ureteral calculi as final, and of greater value than the clinical history or the results of a most painstaking physical examination, or both methods combined. As a result of the accuracy with which these lesions are recognized by skilled röntgenologists, few if any experienced surgeons of the present day will accept the responsibility of treating a complicated fracture or of advising surgical intervention in a case of urinary calculi without the aid of a röntgenologic examination, if it is possible or practicable to obtain one.

What then is the present status of röntgenology in surgical lesions of the stomach and duodenum? A brief review of the history and development of gastro-intestinal röntgenology may help to answer this question.

The first report on röntgenographic examination of the human stomach was published by Hemmeter in 1896.[1] Early röntgenograms of the stomach were blurred and unsatisfactory, because long exposures were required. The fluoroscopic screen was therefore the more success-

* Read before the American Surgical Society, April 9, 1914.

[1] Hemmeter: Photography of the Human Stomach by the Roentgen Method, Boston Med. and Surg. Jour., p. 609, June 18, 1896.

ful method until instantaneous röntgenograms were made possible by the advent of the intensifying screen. Not long afterwards, Kaestle, Rieder and Rosenthal [2] reported their bioröntgenographic observation of the gastric motor phenomena; but subsequent publications fail to show that they have taken advantage of this valuable method for practical diagnosis. Inspired by their work, we started by making 12 röntgenograms in rapid succession. This number has been gradually increased until now we always make 40 and usually 50 or 60 röntgenograms in several series, with the patient in various postures, and at intervals of two hours, until the stomach is empty, a method to which the name serial röntgenography has been applied. These röntgenograms are studied individually and collectively and superimposed upon each other for comparison, or reproduced cinematographically.

Recently we have perfected a true röntgenocinematographic machine capable of making 50 röntgenograms of a single cycle, or 200 röntgenograms of the progression of an individual peristaltic contraction from the fundus to the pylorus in a 4-cycle type of stomach. The information gained by such an examination or by serial röntgenography includes:

Size, position and shape or type of the stomach.

Activity of the peristalsis, and width of the peristaltic contractions.

Character of the systole and diastole.

Depth of the rugæ and the direction in which they run.

Degree of dilatation, and the motor phenomena of the descending and horizontal duodenum.

Pyloric sphincter, whether clear-cut and well defined on both surfaces and $^{3}/_{16}$ inch wide, or irregular in contour and wider than normal.

Cap (pilleus ventriculi), whether symmetrical, corresponding in size and contour with the pars pylorica, or invisible, deformed, or spasmodically contracted.

The first inch and one-half of the gut, beyond the pyloric sphincter, viz., the cap (pilleus ventriculi), is stomach and not duodenum, considered embryologically, histologically, physiologically, anatomically and surgically. The cap is the most important portion of the whole gastric tract, and its röntgenologic appearance is of inestimable value in the diagnosis of lesions in the right hypochondrium.

The diagnosis of extensive gastric lesions is based on permanent filling defects in the walls of the stomach or cap, whereas the diagnosis of early lesions, particularly of small, indurated ulcers and adhesions, is based on the interruption of peristaltic contractions as they progress

[2] Kaestle, Rieder and Rosenthal: The Bioröntgenography of the Internal Organs. Arch. of the Roent. Ray, June, 1910, p. 3.

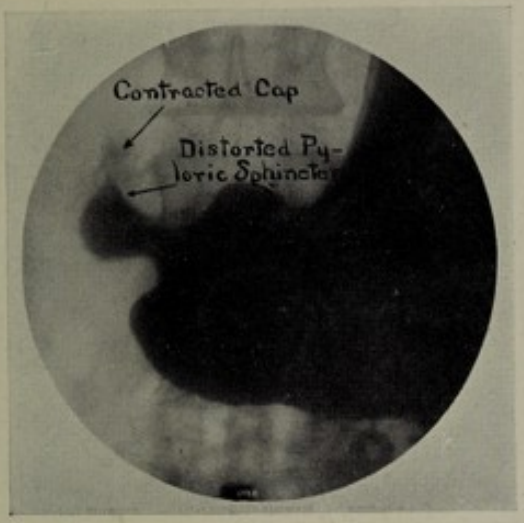

FIG. 1.—Clinical diagnosis: Ulcer of the cap. Röntgenologic diagnosis: Ulcer of the cap. Surgical findings: Ulcer of the cap. Case I.

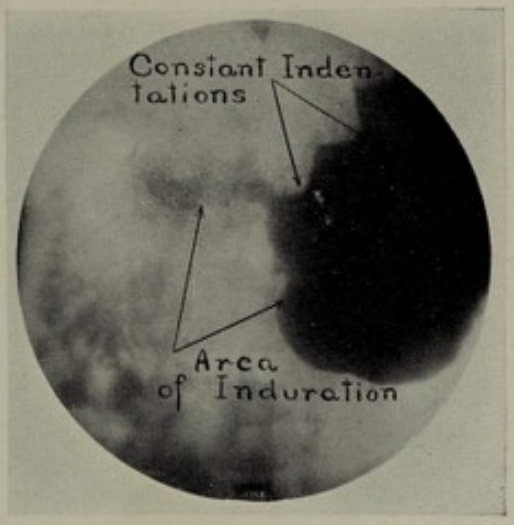

FIG. 2.—Clinical diagnosis: Gastric ulcer. Röntgenologic diagnosis: Gastric ulcer, with extensive induration, extending along greater and lesser curvatures of entire pars pylorica. Surgical findings: Massive, gummatous induration, occupying pyloric extremity of stomach and extending from greater to lesser curvature. Chronic ulcer. Case II.

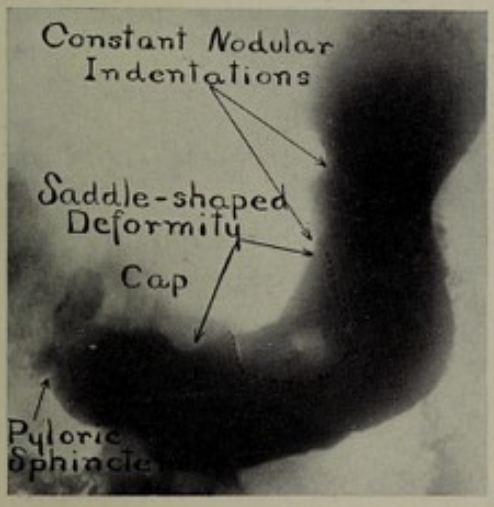

FIG. 3.—Clinical diagnosis: Gastric cancer. Röntgenologic diagnosis: Extensive carcinoma, involving entire lesser curvature. Surgical findings: Extensive carcinoma, involving most of lesser curvature. Case III.

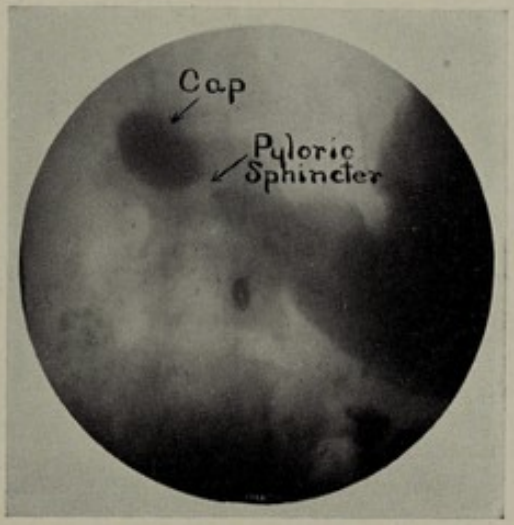

FIG. 4.—Clinical diagnosis: Ulcer of the cap. Röntgenologic diagnosis: Normal stomach and cap. Surgical findings: Normal stomach and cap. Case IV.

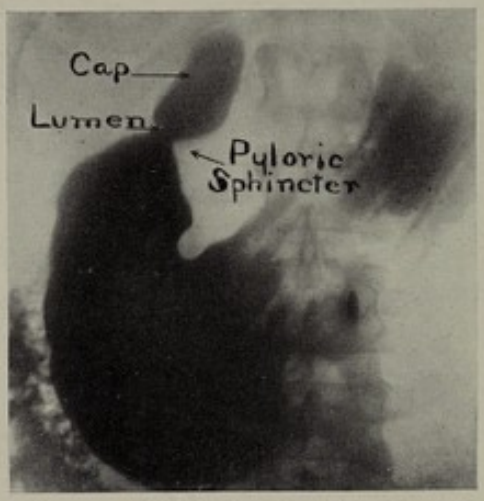

FIG. 5.—Clinical diagnosis: Ulcer of the cap. Röntgenologic diagnosis: Normal stomach and cap. Surgical findings: Normal stomach and cap; diseased appendix. Case V.

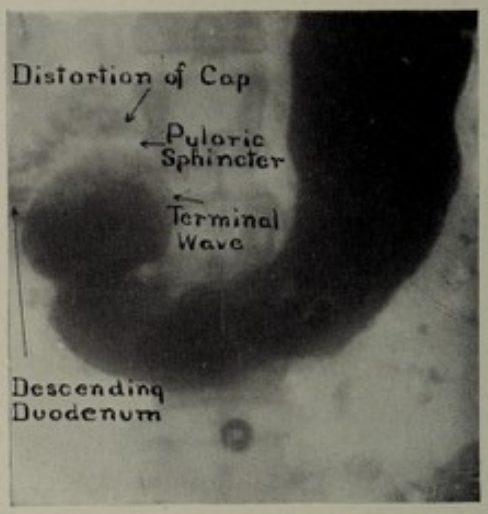

FIG. 6.—Clinical diagnosis: Gall-bladder infection. Röntgenologic diagnosis: Gall-bladder adhesions, involving the cap. Surgical findings: Gall-bladder adhesions involving the cap. Case VI.

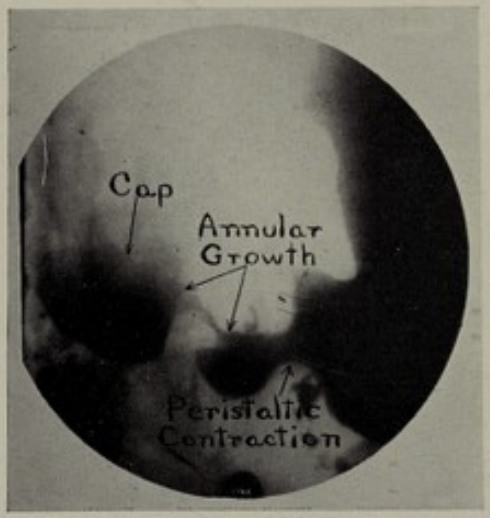

FIG. 7.—Clinical diagnosis: Gastric carcinoma. Röntgenologic diagnosis: Carcinoma, involving pars pylorica, more extensive on the lesser curvature. Surgical findings: Carcinomatous induration involving the pylorus and extending along the lesser curvature. Case VII.

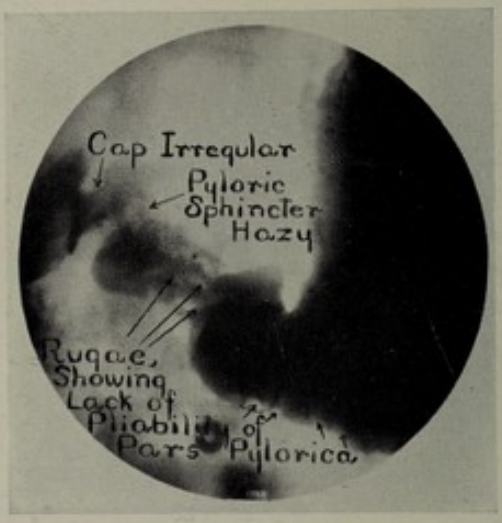

FIG. 8.—Clinical diagnosis: Ulcer of the cap. Röntgenologic diagnosis: Lack of normal expansion and contraction of gastric walls, due to some functional disturbance. Case VIII.

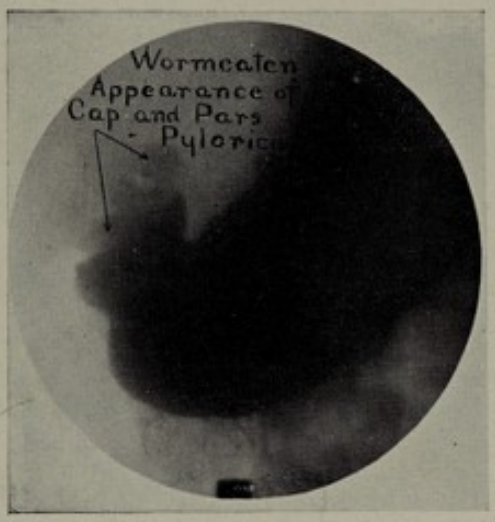

FIG. 9.—Clinical diagnosis: Intestinal obstruction. Röntgenologic diagnosis. Gall-bladder infection with a calculus, causing adhesions involving pars pylorica. Surgical findings: Gall-stone obstructing upper part of jejunum, cholecystitis. Case IX.

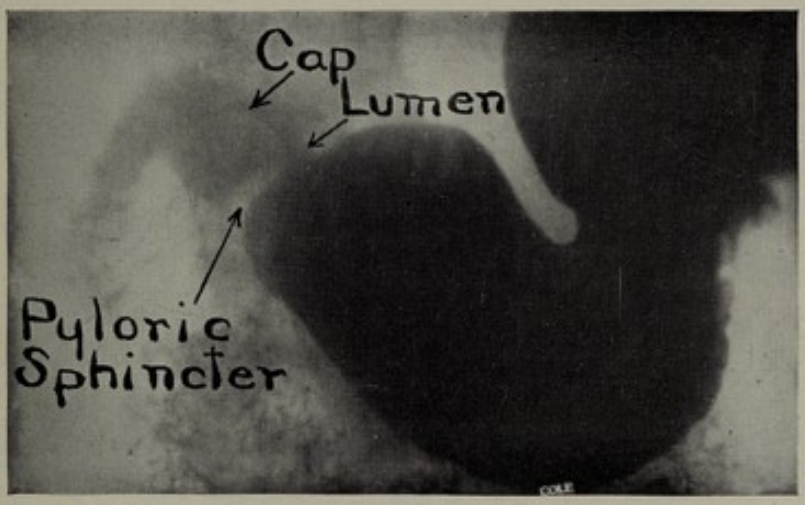

FIG. 10.—Clinical diagnosis: Ulcer of the cap. Röntgenologic diagnosis: Spasm of cap and pars pylorica. No organic lesion of stomach or cap. Surgical findings: Normal stomach and duodenum. Case X.

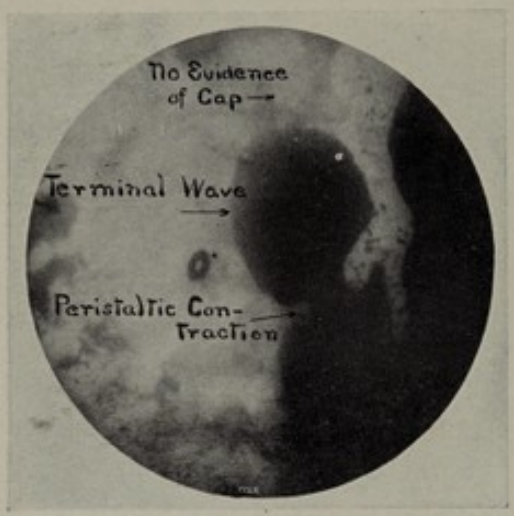

FIG. 11.—Clinical diagnosis: Ulcer of the cap. Röntgenologic diagnosis: Ulcer of the cap. Surgical findings: Ulcer of the cap. Case XI.

FIG. 12.—Clinical diagnosis: Ulcer of the cap. Röntgenologic diagnosis: Ulcer of the cap, with adhesions involving the pyloric sphincter and lesser curvature of pars pylorica. Surgical findings: Ulcer of the cap with dense induration extending for a short distance along lesser curvature of stomach. Case XII.

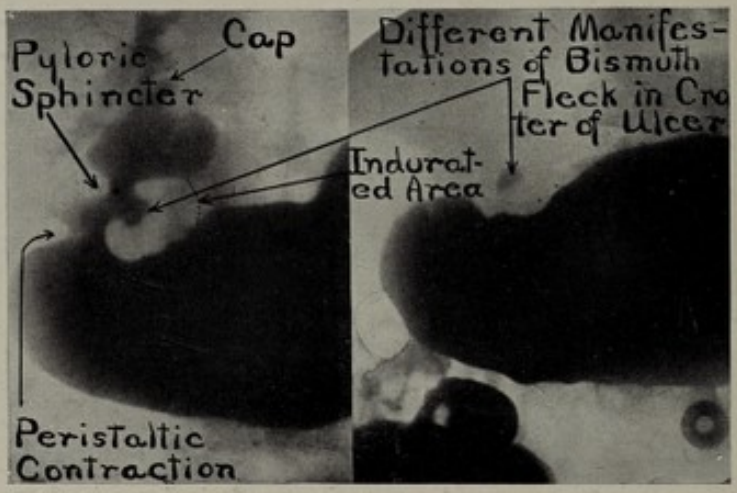

FIG. 13.—Clinical diagnosis: Gastric or duodenal ulcer. Röntgenologic diagnosis: Ulcer of the gastric side of the pyloric sphincter, most of the induration involving the stomach on the lesser curvature, although the cap also is encroached upon. Surgical findings: Induration of the cap near the pylorus, with slight thickening along lesser curvature of stomach for three-fourths of an inch. Case XIII.

FIG. 14.—Clinical diagnosis: Ulcer of the cap. Röntgenologic diagnosis: No evidence of gastric or duodenal lesion. Surgical findings: Normal stomach and cap. Case XIV.

FIG. 15.—Clinical diagnosis: Ulcer of cap or stomach. Röntgenologic diagnosis: Minute ulcer, with induration involving cap, pyloric sphincter and lesser curvature of pars pylorica. Surgical findings: Small, shot-like induration on duodenal side of pylorus. Case XV.

FIG. 16.—Clinical diagnosis: Definite ulcer of the cap. Röntgenologic diagnosis: Normal stomach and cap. Surgical findings: Normal stomach and cap. Case XVI.

FIG. 17.—Clinical diagnosis: Definite ulcer of the cap. Röntgenologic diagnosis: Obstruction at duodenojejunal junction. Displacement upwards of transverse colon by tumor mass. Surgical findings: Obstruction at duodenojejunal junction by enlarged tuberculous retroperitoneal glands. Case XVII.

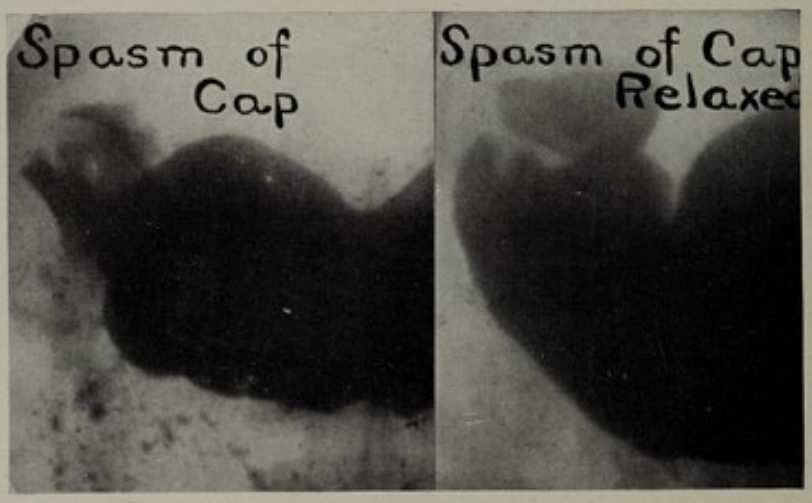

FIG. 18.—Clinical diagnosis: Ulcer of the cap. Röntgenologic diagnosis: Spasmodic constriction of the cap. Surgical findings: Normal stomach and cap; diseased appendix. Case XVIII.

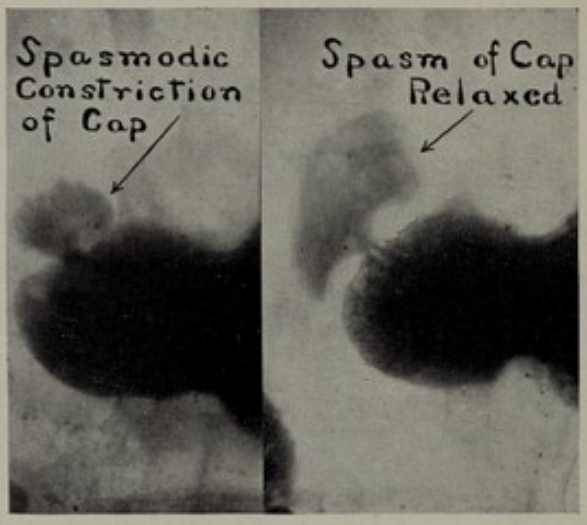

FIG. 19.—Clinical diagnosis: Perforated gastric ulcer. Röntgenologic diagnosis: Spasmodic constriction of cap, caused by acute angulation in first portion of transverse colon. No organic lesion of stomach or cap. Surgical findings: Normal stomach and cap. Adhesions of ascending colon. Case XIX.

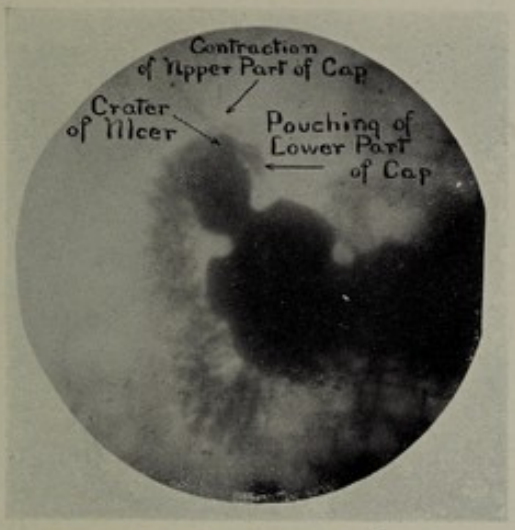

FIG. 20.—Clinical diagnosis: Gastric ulcer four inches from pylorus. Röntgenologic diagnosis: Ulcer of the cap. Surgical findings: Ulcer of the cap. Case XX.

FIG. 21.—Clinical diagnosis: Ulcer of the cap. Röntgenologic diagnosis: Ulcer of the cap. Surgical findings: Normal stomach and cap; diseased appendix. Case XXI.

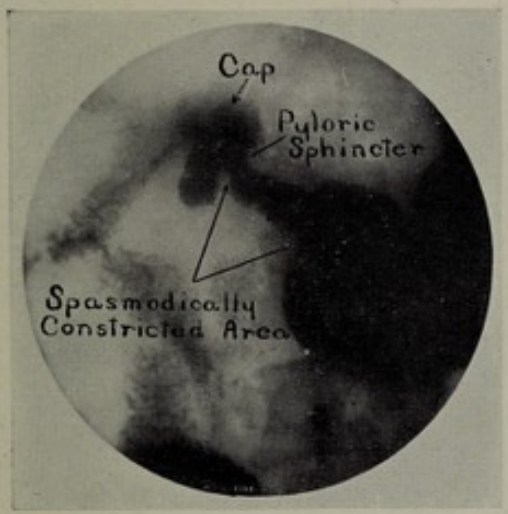

FIG. 22.—Clinical diagnosis: Ulcer of stomach or cap. Röntgenologic diagnosis: Annular lesion of pars pylorica. Surgical findings: Normal stomach and cap. Case XXII.

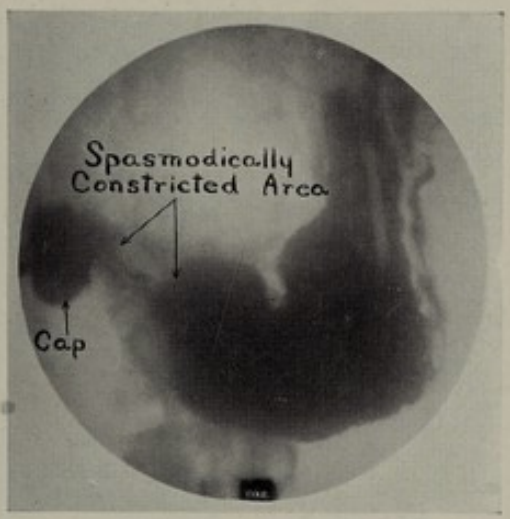

FIG. 23.—Another manifestation of spasm of pars pylorica, which presented in Case XXII.

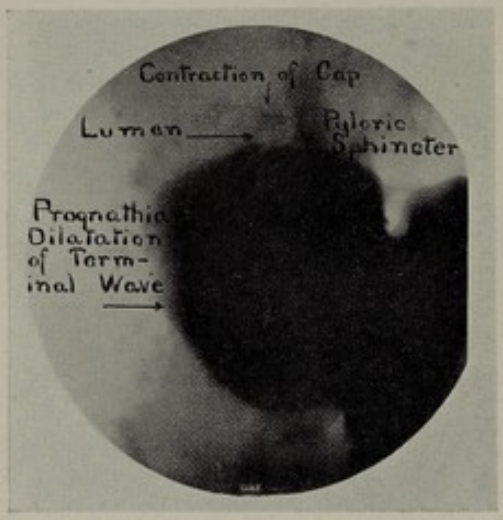

FIG. 24.—Clinical diagnosis: Ulcer of the cap. Röntgenologic diagnosis: Ulcer of the cap. Surgical findings: Ulcer of the cap. Case XXIII.

FIG. 25.—Clinical diagnosis: Ulcer of the cap. Röntgenologic diagnosis: Ulcer of the cap. Surgical findings: Ulcer of the cap. Case XXIV.

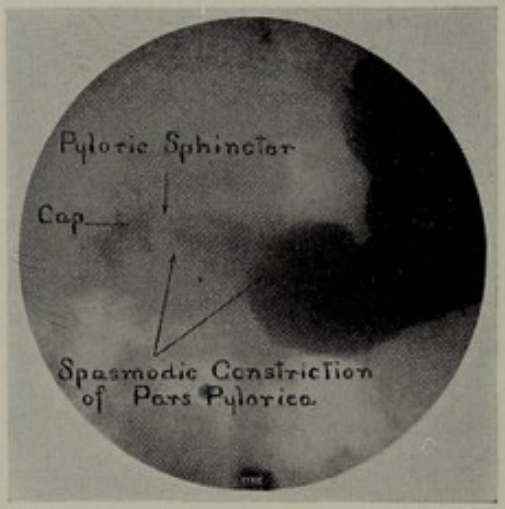

FIG. 26.—Clinical diagnosis: Gastric or duodenal lesion. Röntgenologic diagnosis: Spasmodic contraction of cap and pars pylorica. Surgical findings: Normal stomach and duodenum. Case XXV.

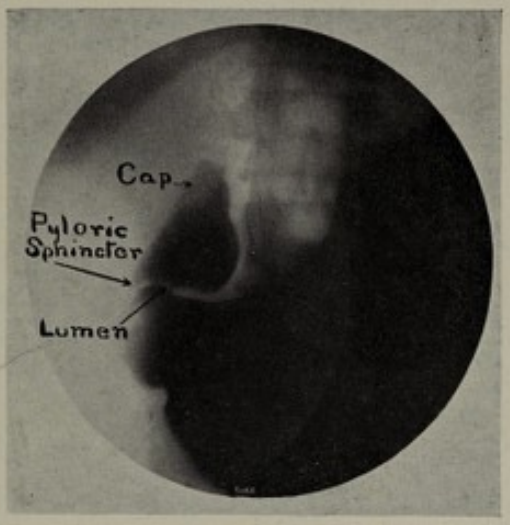

FIG. 27.—Clinical diagnosis: Ulcer of the cap. Röntgenologic diagnosis: Functional derangement of gastric digestion; no organic lesion of stomach or cap. Surgical findings: Normal stomach and cap. Case XXVI.

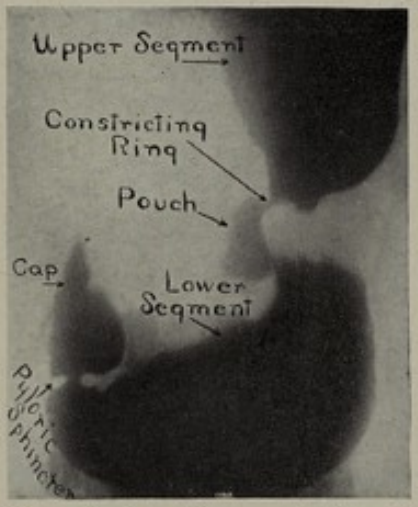

FIG. 28.—Clinical diagnosis: Gastric lesion of three months' duration. Röntgenologic diagnosis: Hour-glass stomach. Surgical findings: Hour-glass stomach. Case XXVII.

pyloruswards. The wealth of detail obtained when the bismuth is suspended in buttermilk enables one to differentiate many non-malignant lesions from indurated gastric ulcer or carcinoma. Theoretically the method of interpreting röntgenographic findings is much the same as that employed by the pathologist in making a diagnosis from a pathologic specimen. All of the evidence assembled is utilized in making deductions, no single phenomenon being accepted as conclusive proof of a condition.

The interpretation of the röntgenograms and the diagnosis of the 27 consecutive cases described in this communication are the result of a study of about 20,000 röntgenograms of 700 cases. The 27 cases reported herein include all cases examined röntgenographically by Dr. Cole and subsequently operated upon by Dr. Brewer. Each case was referred to Dr. Cole with the simple statement that an organic lesion of the stomach or duodenum was suspected; no history or data obtained by physical examination or gastric analysis being furnished. As a result of the röntgenographic examination, a typewritten report was returned, giving the exact findings and an opinion regarding the presence or absence of a gastric or duodenal lesion, its location, extent and probable cause. In several cases a lesion of some other portion of the gastro-intestinal tract was diagnosticated. Later each case was explored, and the findings at operation were recorded.

The röntgenologic report on the first three cases will be given in full to indicate the method employed and the reasons for the final diagnosis. In the other cases only the final conclusions will be quoted. The full reports are on file in Dr. Cole's library and in the hospital records.

CASE I.—*Clinical History.*—C. H. P.; man; chronic dyspepsia for ten years. Began with pain after meals, belching of gas, and occasional sour eructations. Always worse after severe nervous strain. Some relief from medical treatment. Present condition: well nourished, active man. Complains of pain of a heavy, burning character one to three hours after meals. Often relieved by food or vomiting. History of occasional attacks of pain in right iliac fossa. Gastric analysis showed marked hyperacidity.

Röntgenographic Findings.—Three röntgenograms of the gall-bladder region show the ribs, spine, transverse processes and kidney distinctly. There is no evidence of any shadow which could possibly be interpreted as a gall-stone, but one is not justified in making a negative diagnosis of this condition solely from the röntgenographic findings.

A series of röntgenograms of the stomach, made with the patient in both the prone and erect postures, and in the anterior and posterior directions, shows its size, shape and position distinctly.

Type: Text-book.

Size: Dilated.

Position: Slightly prolapsed.

Peristalsis: 3 cycle type, equal on the greater and lesser curvatures, and unobstructed, except possibly at the extreme pyloric end of the stomach.

Systole and diastole: Shown distinctly.

Jejunum: Shown distinctly.

Duodenum (descending and horizontal portions): Shown distinctly.

Cap (first portion of the duodenum): Contracted in all the röntgenograms, and fails to have the clear-cut, well-defined edges of a normal cap.

Pyloric sphincter: Distorted by the contraction of the cap, especially on its duodenal surface.

The extreme pyloric end of the stomach on the lesser curvature presents a cup-shaped depression, which may be due either to a slight involvement by adhesions, or to a pressure from without.

A plate made 6 hours after the ingestion of bismuth, and after the patient had eaten a chop, baked potato and bread, shows considerable retention of food in the stomach. The outer side of the cap shows more distinctly than the inner, indicating that the lesion is on the left side of the cap.

Röntgenologic Diagnosis.—From a study of these plates, I believe we are justified in making a negative diagnosis of new growth of the stomach. There is, however, a definite lesion involving the cap. This does not have any of the röntgenographic evidence of malignancy, and I believe that it is due to a cicatricial contraction either from a duodenal ulcer or from gall-bladder infection. The weight of the evidence is strongly in favor of a duodenal ulcer on the lesser curvature side of the cap. Considering the definite lesion of the cap, and the moderate dilatation of the stomach and the retention of food after six hours, I believe that surgical procedure is indicated regardless of the symptoms.

Surgical Findings.—The stomach was normal. In the duodenal wall, one-half inch from the pylorus, was an oval indurated nodule, about 2 cm. in diameter.

A posterior gastro-enterostomy was performed.

A chronically thickened appendix was also removed through a second incision.

CASE II.—*Clinical History.*—O. H.; man; thirty-two years old. Chronic indigestion for seven years. Pain, sense of weight, nausea, and sour eructations after meals, often relieved by vomiting. Would often induce vomiting to relieve pain. Has lost flesh and strength through lack of food. No relief from eating. In hospital complained of severe pain after solid food. Gastric analysis showed hyperacidity. Wassermann test: 4 plus.

Röntgenographic Findings.—Röntgenograms focussed over the gall-bladder region show no evidence of any shadow which could possibly be

interpreted as a gall-stone, but one is not justified in making a negative diagnosis of such a condition solely from the röntgenographic findings.

A series of röntgenograms of the stomach, made immediately after, and two, seven and one-half, and twenty-three hours after the ingestion of bismuth, shows the size, shape and position of the stomach, and the progress of the food through the tract.

Type of stomach: Deformed.

Size: Normal.

Position: Normal.

Peristalsis: 3 cycle type, obstructed on both greater and lesser curvatures in region of pars pylorica.

Systole and diastole: Shown distinctly.

Jejunum: Shown distinctly.

Duodenum (descending and horizontal): Shown distinctly.

Cap (first portion of duodenum): Contracted on left side.

The entire pars pylorica, and part of the pars media fail to expand and contract in a normal manner. Although the food begins to pass out of the stomach at an early stage after ingestion, there is considerable gastric retention seven and one-half hours later. In these röntgenograms the head of the bismuth column is at the hepatic flexure. The terminal portion of the ileum is considerably dilated.

Röntgenologic Diagnosis.—The findings indicate the presence of a primary gastric ulcer, the crater of which lies about 3 inches from the pyloric sphincter. Extensive induration surrounds the ulcer and extends along the greater and lesser curvatures of the pars pylorica, which shows annular constriction. Two torsive folds extend up along the gastric wall. The cap also is involved in adhesions. Whether or not any of the induration surrounding the ulcer has begun to undergo carcinomatous changes as yet, can be determined only by microscopic examination after its removal.

Surgical Findings.—A massive induration occupied the pyloric extremity of the stomach and extended from the lesser to the greater curvature, chiefly on the posterior surface. This was adherent to the transverse mesocolon, which was so infiltrated as to preclude the possibility of a posterior gastro-enterostomy. A number of enlarged lymph-nodes were present along the greater curvature, two of which were removed for microscopic examination.

An anterior gastro-enterostomy was done by the suture method.

Pathologist's Report.—The enlarged lymph-nodes showed no malignancy, only inflammatory hyperplasia.

Diagnosis: Chronic ulcer of the stomach with extensive gummatous infiltration.

CASE III.—*Clinical History.*—W. H.; man; age thirty-nine. Three months before admission began to have food distress with sharp pain radiating to left side of chest, sour eructations, and constant hunger. Food often relieves the pain. There is no loss

of weight or strength. Physical examination revealed movable tumor in epigastrium.

Gastric analysis: No free HCl or lactic acid. Trace of blood. Hæmoglobin, 59 per cent.

Röntgenographic Findings.—A series of röntgenograms of the stomach, made immediately and three hours after the ingestion of bismuth, shows the size, shape and position of the stomach distinctly.

Type: Deformed.

Size: Normal.

Position: Normal.

Peristalsis: 2 cycle type. Obscured along the entire lesser curvature.

Jejunum: Shown distinctly.

Duodenum (second and third portions): Shown distinctly, is symmetrical, corresponding in contour with the pyloric end of the stomach; separated from the pars pylorica by a space of about ⅛ inch, indicating the pyloric sphincter, both surfaces of which are clear-cut, and the lumen of which is centrally located.

There is no evidence of peristalsis on the lesser curvature, and its contour from the cardia to within 1½ inches of the pylorus is absolutely constant in all the röntgenograms. The involvement extends down along both the anterior and posterior walls of the stomach.

Röntgenologic Diagnosis.—The röntgenologic evidence in this case indicates an extensive new growth involving the entire lesser curvature in much the same manner as a saddle-shaped ulcer. Considering its great extent, and the constant nodular indentations, presenting the finger-print appearance, I believe we are justified in making a diagnosis of carcinoma too extensive for reasonable hope of removal.

Surgical Findings.—An extensive saddle-shaped carcinoma involved most of the lesser curvature, and extended downward on both anterior and posterior surfaces. There was no definite induration at the pyloric ring.

A partial gastrectomy was performed.

Case IV.—*Clinical History.*—O. V.; woman; age thirty-three. Early history of appendix infection followed by appendectomy seven years ago. Complains of epigastric pain four hours after meals. Sour eructations and frequent vomiting of sour material with relief of pain. Has lost weight and strength. No jaundice. Physical examination negative, except for epigastric tenderness.

Gastric analysis: Free HCl, 30. Total, 60. Blood present in small amount.

Röntgenographic Diagnosis.—There is no evidence of new growth, indurated ulcer or adhesions involving the stomach or cap, and therefore no röntgenologic indication for surgical procedure on the stomach or duodenum.

Surgical Findings.—The stomach and duodenum were normal. A chronically thickened and adherent gall-bladder was found, containing two large stones.

A cholecystectomy was performed.

CASE V.—*Clinical History.*—Mrs. H.; age forty. Patient has a history of having had several acute attacks of abdominal pain and fever, followed by soreness in the lower abdomen. One of these attacks had been diagnosticated as acute appendicitis by a competent physician, who advised operation in the interval. Subsequently she had suffered from digestive distress with more or less epigastric pain, gas, and sour eructations after meals. These symptoms would occur at variable intervals, last two or three weeks, and then disappear. On examination there was tenderness over the right hypochondriac and epigastric regions. Also tenderness at McBurney's point.

Röntgenologic Diagnosis.—There is no evidence of adhesions or new growth involving the stomach or cap. The first bismuth which passed out of the stomach proceeded rapidly through the jejunum and upper part of the ileum into the ascending and transverse colon. The food then ceased to pass through the second and third portions of the duodenum, although a large amount of bismuth still remained in the stomach and cap. The fact that the pylorus was open indicates that there was no obstruction to account for this retention at the pyloric sphincter.

Surgical Findings.—The stomach, duodenum, and gall-bladder were normal. A chronically diseased appendix was removed through a second incision.

CASE VI.—*Clinical History.*—Mrs. B.; age forty-four. Appendix removed several years ago. For past two years patient has complained of more or less constant epigastric distress after meals, with occasional vomiting of sour material. At frequent intervals this distress would become accentuated, and associated with severe pain over the region of the gall-bladder. While the symptoms were rather indefinite, the patient had lost much weight and strength and found it difficult or impossible to attend to her household duties. Physical examination revealed a generalized tenderness over the entire epigastric region, and well-marked Murphy's sign.

Röntgenologic Diagnosis.—The röntgenographic examination revealed only a slight distortion of the cap, probably due to an adhesion of the gall-bladder.

Surgical Findings.—There was a small band of inflammatory adhesion at the summit of the gall-bladder and adjacent liver border, extending to the junction of the first and second portions of the duodenum. This was divided.

CASE VII.—*Clinical History.*—E. S., woman. For the past

seven months this patient had suffered from a progressively increasing epigastric distress after eating, belching of gas, and of late, frequent vomiting. Record of physical examination, gastric analysis, and blood test have been lost.

Röntgenologic Diagnosis.—The extreme pyloric end of the stomach is constricted by an annular growth, more extensive on the lesser curvature than on the greater, and more extensive anteriorly than posteriorly. The weight of the evidence is in favor of the growth's being malignant. Immediate surgical procedure is indicated.

Surgical Findings.—A fairly extensive carcinomatous induration was found, involving the pylorus and extending along the lesser curvature half way to the œsophageal junction.

A partial gastrectomy was performed.

Case VIII.—*Clinical History.*—N. H.; man. Seven years ago began to experience pain after eating, located in epigastrium, often relieved by food. Symptoms would occur in periods varying from 4 to 6 weeks at a time, followed by more or less complete relief for a longer or shorter period. Ever since onset of symptoms has had more or less dyspepsia with acid eructations. Occasional attacks of pain and discomfort over appendicular region without reference to the taking of food. At present, pain more pronounced three or four hours after mid-day meal.

Röntgenologic Diagnosis.—There is no evidence of new growth or indurated gastric ulcer. The irregular shape of the cap, the hazy edges of the sphincter, the lack of normal expansion and contraction of the pyloric end of the stomach, together with the appearance of the peristaltic contractions and the abnormal rugæ in this region, indicate that there is some lesion involving this portion of the stomach, probably adhesions, either from gall-bladder infection or from an ulcer. No evidence of an indurated gastric ulcer can be detected, but the constant indentation in the left side of the cap may be a duodenal ulcer. The fact that the food passed readily out of the stomach during the early stage of digestion indicates that there is no pyloric obstruction. The stasis of food in the stomach six hours after its ingestion, however, would indicate that there was an obstruction; but this stasis is probably due to some functional disturbance of the stomach or duodenum, rather than to an organic obstruction of the pylorus.

Excerpt from Dr. Cole's letter to Dr. Brewer: "This case of Mr. H. is typical of a group of about 20 cases, which show evidence of a definite lesion involving the pyloric end of the stomach and the cap. I have never felt that I could advocate surgical procedure in any such instances, although I am exceedingly anxious to know what pathologic condition causes these röntgenographic findings."

Surgical Findings.—The stomach and duodenum were normal. No evidence of cholelithiasis or inflammation of the gall-bladder could be found. The appendix was removed. It was thickened, presented an obliterating stricture in its distal third, and was distended at the tip.

CASE IX.—*Clinical History.*—L. R.; woman. Patient was first seen by the writer during an attack of incomplete intestinal obstruction. Prior to the occurrence of these symptoms, she had suffered from dyspeptic symptoms for a number of years, associated with occasional attacks of severe epigastric pain. Shortly before the symptoms of obstruction appeared, two series of röntgenograms of the stomach and duodenum were made.

Röntgenologic Diagnosis.—The shadow in the gall-bladder region is a little too high for the normal position of the gall-bladder, but it certainly has the appearance of a rather large gall-stone. The absence of the duodenum, the contracted cap, the irregular and worm-eaten appearance of the pylorus, and the absence of the pyloric sphincter indicate a lesion in this region which calls for surgical procedure. This lesion is probably adhesions from gall-bladder infection with a calculus, but considering the irregular worm-eaten appearance of the pyloric end of the stomach, the possibility of carcinomatous degeneration cannot be eliminated.

Surgical Findings.—The upper part of the jejunum was distended. On following the distended bowel downward for about one meter, a hard oval mass was found, almost completely filling the lumen. Below this mass the bowel was collapsed. On opening the bowel, the obstruction mass was found to be an enormous oval gall-stone, measuring 3 cm. in its long diameter, and 2 cm. in its short diameter. The presence in the upper jejunum of a gall-stone of this size could be explained only by its sloughing through the walls of the gall-bladder and duodenum, creating the lesion described in the röntgenologic report.

CASE X.—*Clinical History.*—F. C.; woman. Entered the hospital for attacks of epigastric pain and sour vomiting. Appendix removed 18 months before admission. Since that operation has complained constantly of irritable stomach, irregular pains in epigastric, inguinal and umbilical regions, prostration, weakness, loss of flesh, and vomiting. Gastric analysis: Free HCl, 26; total acidity, 50; no lactic acid or blood.

The clinical picture was not characteristic of any definite lesion, but as the patient was practically bedridden, and constantly losing flesh, an exploratory operation was advised.

Röntgenologic Diagnosis.—There is no röntgenologic evidence of gastric carcinoma or indurated ulcer. The incomplete filling of the cap in the majority of the plates would make one extremely

suspicious of a duodenal ulcer, but as a practically normal cap presents in one or two of the röntgenograms, its constriction in the majority of the plates must be due to a spasmodic contraction, probably associated with a pylorospasm. There is a slight possibility that this pylorospasm is caused by a small duodenal ulcer on the lesser curvature of the cap, but there is not sufficient evidence to justify one in coming to such a conclusion.

Surgical Findings.—The stomach and duodenum as well as the gall-bladder, pancreas and colon were normal.

CASE XI.—*Clinical History.*—J. McG.; man. Three years ago began to have epigastric pain after meals, generally relieved by food and occasionally by belching. Freedom from symptoms for periods of variable duration. Occasional attacks of sudden weakness with marked pallor. Did not notice color of stools. All symptoms relieved when on a purely milk diet, but would return on resuming solid food. Gastric analysis: Free HCl, 80; total, 105; no lactic acid or blood.

Röntgenologic Diagnosis.—Röntgenograms of the stomach show no evidence of new growth or indurated ulcer. The absence of the cap justifies a suspicion of some lesion involving this portion of the duodenum, possibly a duodenal ulcer. But the fact that the chyme passes rapidly out of the stomach into the second and third portions of the duodenum, jejunum, and even down into the ileum, indicates that there is little or no obstruction to the evacuation from the stomach of fluid contents. Unfortunately four- and six-hour plates, to determine how completely the stomach emptied itself, were not made.

Surgical Findings.—The stomach was somewhat dilated. A moderate-sized induration was found in the first part of the duodenum, one-half inch from the pylorus. The peritoneal surface of the duodenum was puckered and scarred over the surface of the induration. A posterior gastro-enterostomy was performed.

CASE XII.—*Clinical History.*—T. M.; man. Suffered for two years from pain two or three hours after meals, relieved by vomiting or taking more food. Often induces vomiting to relieve pain. Of late has had copious vomiting once every three or four days. No blood in vomitus. Stools often black in color. Loss of forty pounds in weight. Gastric analysis: Free HCl, 40; total, 60; no lactic acid or blood.

Röntgenologic Diagnosis.—There is an obstruction of the cap, causing an immense dilatation of the stomach. This is caused by an ulcer on the anterior surface of the cap. Surrounding adhesions involve the pyloric sphincter, and possibly also extend on to the stomach.

Surgical Findings.—There was a dense indurated area in the

first part of the duodenum, extending for a short distance along the lesser curvature.

A gastro-enterostomy was performed.

CASE XIII.—*Clinical History.*—P. O'B.; man. For 5 years patient has suffered from a gnawing pain in the epigastrium, coming on 2 or 3 hours after eating, and continuing until relieved by next meal. There are frequent eructations of gas during period of pain, and occasionally a small amount of sour irritating fluid rises in the throat. Stools often black in color. Has vomited only twice. No blood seen in vomitus. Has not lost weight or strength.

Röntgenologic Diagnosis.—A definite lesion involves the extreme pyloric end of the lesser curvature of the stomach, causing an anterior retraction of the cap. This corresponds with an ulcer of the cap, but röntgenographic findings indicate that most of the induration involves the stomach, rather than the cap, although the lesion may have started in the postpyloric surface of the sphincter. There is no evidence of obstruction. The bismuth filled crater and the everted edges of the ulcer, viewed in profile, are classical. Whether or not there are any carcinomatous changes at the base of this ulcer, can be determined only by a microscopic examination.

Surgical Findings.—A duodenal induration was found near the pylorus, with slight thickening along the lesser curvature for a distance of ¾ inch.

A gastro-enterostomy was performed.

CASE XIV.—*Clinical History.*—Since first child was born 22 months ago, patient has suffered almost constantly with dull epigastric pain, which has no relation to eating. Pain radiates over whole abdomen, but is marked in upper right quadrant, and frequently passes through to back and up to shoulder. Causes vomiting when severe. Vomitus bitter, with dark red streaks like blood on two or three occasions. Bowels constipated. Stools very dark. No urinary symptoms. Has never been jaundiced. Has lost about 40 pounds in 3 years.

Röntgenologic Diagnosis.—The röntgenographic findings justify a negative diagnosis of new growth of the stomach, except possibly at a minute area near the pylorus. The incomplete filling of the cap, the abnormal pyloric sphincter, and the constant indentation on the lesser curvature of the extreme pyloric end of the stomach, are the most important röntgenographic findings, and indicate some lesion at this point. Considering the incompleteness of examination, one is not justified in stating with certainty whether there is an ulcer of the cap or adhesions from some other cause.

Surgical Findings.—The stomach, duodenum, and gall-bladder were normal. A chronic appendix was removed.

CASE XV.—*Clinical History.*—J. A.; man. About 6 months

ago developed dull, "grinding" pain in epigastrium about 1 hour after meals, lasting from 10 to 20 minutes; never very severe. Does not radiate up or down, is relieved by medication, belching or taking food, and has never caused vomiting. Symptoms disappear on rigid dieting, but return when regular diet is resumed. Stools not tarry in color; bowels regular; no urinary disturbance.

Röntgenologic Diagnosis.—The röntgenographic findings present no evidence of gastric carcinoma. The increased width of the pyloric sphincter on the lesser curvature side of the lumen, and the irregularity of the extreme pyloric end of the stomach and the left side of the cap, indicate that there is a minute lesion involving the cap, sphincter, and the extreme pyloric end of the stomach. The entire involvement, including induration and adhesions, is less than half an inch in diameter, and causes absolutely no interference with the evacuation of the stomach. In fact, it probably acts as an irritant, causing the stomach to evacuate itself with more than normal rapidity. This is by far the smallest lesion that I have been able to recognize by this method of examination. It corresponds with Codman's pathologic description of a healed ulcer, or my own conception of an extremely early ulcer.

Surgical Findings.—A small, shot-like induration was discovered on the duodenal side of the pylorus. The stomach was normal.

A gastro-enterostomy was performed.

Case XVI.—*Clinical History.*—R. R.; woman. For the past six months, patient has suffered from abdominal pain, chiefly located in right iliac fossa, aggravated by taking solid food. Pain increases about half an hour after meals. Some nausea. No vomiting. Is much troubled by belching of gas and sour eructations. Has lost 20 pounds.

Gastric analysis: Free HCl, 29; total, 51; no lactic acid or blood.

Röntgenologic Diagnosis.—The röntgenographic findings justify a negative diagnosis of new growth or indurated ulcer of the stomach or cap. The localized collection of bismuth in a coil of the intestine, in the position of the third portion of the duodenum, is a very constant finding in all the röntgenograms. This is probably due to a kink at this point with partial obstruction, but it is difficult to conceive of such a kink in this region. There is no röntgenographic indication for surgical procedure upon the stomach or cap, but if the symptoms correspond with the localized accumulation of bismuth above described, the plates could then be used as strong corroborative evidence for operative procedure.

Surgical Findings.—No lesion of stomach, duodenum or gall-bladder was found. Upper portion of jejunum was examined and found to be normal. Chronically diseased appendix was removed.

CASE XVII.—*Clinical History.*—S. S.; man. Three years ago patient began to notice epigastric pain coming on directly after meals, lasting one to two hours, disappearing spontaneously, leaving him free until the next meal. Induced vomiting at times to relieve pain when very severe. Much troubled by belching and sour eructations during period of pain. Loss of 20 pounds, feels weak and miserable. Gastric analysis: Free HCl, 20; total, 40; no lactic acid or blood.

Röntgenologic Diagnosis.—There is no evidence of new growth or indurated ulcer of the stomach or duodenum. The immense dilatation of a section of the small intestine in the region of the descending and horizontal duodenum indicates that there is a chronic obstruction of the small intestine, probably at the duodenojejunal junction. The displacement of the first portion of transverse colon over a dome-shaped area is suggestive of tumor, possibly at the head of the pancreas. The röntgenologic evidence indicates surgical procedure in region of the duodenojejunal junction.

Surgical Findings.—The stomach and first part of the duodenum were normal. At the duodenojejunal junction was a large, hard, nodular mass behind the parietal peritoneum, surrounding the aorta, adherent to and causing pressure on the first portion of the jejunum. There was also a congenital anomaly of the mesentery, resulting in a large hole or pocket, through which a considerable length of the small intestine passed without constriction. Numerous other enlarged retroperitoneal nodes were found along the root of the mesentery. The condition was diagnosed as probably tuberculosis of the retroperitoneal lymph-nodes. The adhesions between the large glandular mass and the jejunum were separated, relieving the intestinal stenosis.

CASE XVIII.—*Clinical History.*—M. C.; man. For past eighteen months patient has suffered with severe general abdominal pain, coming on immediately after meals, and lasting an hour or two. Belches gas almost continuously. Has never vomited. Bowels regular; has small watery stool three times a day, usually after eating. Several times has noticed blood in stool, last time three months ago. Has lost about 15 pounds in 18 months. Gastric analysis: Free HCl, 20; total, 30; small amount of blood.

Röntgenologic Diagnosis.—There is no röntgenologic evidence of new growth or indurated ulcer of the stomach. The constant irregularity of the cap in all the plates of the prone position, and the irregularity of the pyloric sphincter with the patient in the erect posture indicates that there is a lesion at this point. But considering the symmetry of the cap in a few of the röntgenograms of the erect posture, the lesion should be regarded as spasmodic rather than organic. The cause of the spasm may be

found at the appendix or at some distant point. There is no röntgenologic indication for surgical procedure at pyloric sphincter.

Surgical Findings.—No lesion of the stomach or duodenum was discovered. The appendix was thickened, angulated and imbedded in adhesions.

CASE XIX.—*Clinical History.*—C. S.; man. Admitted to the hospital with a diagnosis of perforated gastric ulcer. Acute epigastric pain, severe and protracted vomiting. Vomitus contains blood. Exquisite tenderness and muscular rigidity in epigastric and right hypochondriac regions. Moderate fever. Blood count, 22,000; polynuclears, 80 per cent. As symptoms were atypical, no operation was advised, and patient was kept under observation for three or four days. At end of that period, all signs of peritoneal irritation having subsided, a series of röntgenograms was made to see if any gastric or duodenal lesion could be demonstrated.

Röntgenologic Diagnosis.—There is no evidence of new growth, indurated ulcer or adhesions of the stomach or duodenum. The acute angulation in the first portion of the transverse colon, if permanent, might possibly cause the symptoms of which this patient complains. It is doubtful if the dilatation in the terminal portion of the ileum is of any pathologic significance.

Surgical Findings.—The stomach, duodenum and gall-bladder were normal. There was a definite band of adhesions on the ascending colon, causing angulation. The adhesions were divided.

CASE XX.—*Clinical History.*—Mrs. H., age sixty-seven. Indigestion since childhood. Eight years ago epigastric distress, occurring regularly 3 to 5 hours after meals, relieved by alkalines or more food. Sour eructations, gas and loss of weight. Increase of symptoms 5 years ago with hæmatemesis. In bed for several weeks. Leube cure. Gastric analysis at that time: Free HCl, 60; total, 104. Occult blood in stools. String test on 2 occasions showed stain, indicating gastric ulcer near cardia.

Röntgenologic Diagnosis.—There is no röntgenologic evidence of new growth or ulcer of the stomach. Extensive adhesions, probably from an old ulcer or gall-bladder infection, involve the cap. It is evidently adherent to the liver. The stasis of food in the stomach 6 hours after ingestion corroborates this diagnosis.

Surgical Findings.—The stomach was moderately dilated. In the first portion of the duodenum was a large indurated mass, ¾ inch in diameter, with extensive adhesions to the surrounding parts. A posterior gastro-enterostomy was performed.

CASE XXI.—*Clinical History.*—M. O.; man. Two and one-half years ago, having been perfectly well previously, the patient began to suffer from dull aching pain in the right lower quadrant, coming on about two hours after meals, accompanied by nausea, but no vomiting. The pain generally passes off in about half an

hour, and is relieved by taking food. Eating meat, or any heavy food makes the pain much worse, and such articles of food have been removed from his diet for some time. Has no acid eructations. Bowels are rather constipated, though fairly regular. Has never noticed blood in movements or tarry stools. Loss of 54 pounds in last two years, though he feels fairly strong. Gastric analysis: Free HCl, 51; total, 39; no lactic acid or blood.

Röntgenologic Diagnosis.—There is very strong evidence of an ulcer of the cap. The site of the ulcer is evidently about ¼ inch distant from the pyloric sphincter.

Surgical Findings.—No lesion of the stomach or duodenum was discovered. A chronically diseased appendix, containing a concretion near the tip, was removed.

NOTE.—Case XXI is one of the two cases in which a definite röntgenologic diagnosis was disproven by surgical procedure. The diagnosis of ulcer of the cap was based on too few röntgenograms to justify a differentiation between ulcer and spasmodic contraction. The hyperæmia and œdema, observed at operation, were undoubtedly the result of a spasm, but no ulcer was found.

CASE XXII.—*Clinical History.*—W. W.; man. Seven years ago had distress in the stomach after eating, and vomited frequently. Occasionally vomitus contained blood. Troubled also with acid eructations. Symptoms continued for four years. Since that time has had a vague soreness over the upper abdomen with gas and occasional vomiting.

Röntgenologic Diagnosis.—An annular lesion involves the extreme pyloric end of the lesser curvature. The growth lacks the characteristic indentations of the "finger-print" appearance of a carcinoma, but it should be considered malignant until proven otherwise by microscopic examination.

Surgical Findings.—No lesion of the stomach, duodenum or gall-bladder was found. The appendix was removed.

NOTE.—Case XXII is the second of the two cases in which surgical procedure proved that the röntgenologic diagnosis was not correct. The röntgenologic findings had all of the characteristics previously described as indicating spasm, but as the area involved was accentuated by a circular constriction, the lesion was considered organic rather than spasmodic. A careful matching of the röntgenograms over each other would have prevented this mistake.

CASE XXIII.—*Clinical History.*—H. P.; man. Syphilis twelve years ago. Heavy drinker until seven months ago. Chronic dyspepsia for years, pain after meals, sour eructations, vomiting and soreness in epigastrium. Of late loss of weight (50 pounds). Vomiting of large quantities of foul undigested food. Gastric analysis: Free HCl, 38; total, 50.

Röntgenologic Diagnosis.—There is no evidence of new growth involving the stomach itself. An obstruction presents at the pylorus, involving either the first portion of the duodenum or the pyloric sphincter, or both. The lesion probably is due to a duodenal ulcer, either old or new. Considering the immense prognathian dilatation of the stomach, and the retention of food, there is no question but that surgical procedure is definitely indicated.

Surgical Findings.—The stomach was enormously dilated. A hard indurated mass, one-half inch in diameter, extended on to first portion of duodenum. A gastro-enterostomy was performed.

CASE XXIV.—*Clinical History.*—M. M.; woman. Indigestion since childhood after tiring work. Occasional sharp attacks of colic in upper abdomen of late. Epigastric distress, occurring after meals, about 11 A.M. and 5 P.M., and after retiring at night. Considerable loss of weight.

Röntgenologic Diagnosis.—There is no evidence of carcinoma or indurated ulcer of the stomach itself. The constant deformity of the cap, viz., the permanent indentation in the upper edge and the pouching of the lower portion, indicates a definite lesion in the upper portion, either from a duodenal ulcer or gall-bladder infection, with the weight of the evidence in favor of the former.

Surgical Findings.—The stomach was found to be normal. A small, shot-like induration presented on the posterior wall of the duodenum, ¼ inch from the pylorus. A gastro-enterostomy was performed.

CASE XXV.—*Clinical History.*—J. P.; man; age forty. The patient had dysentery in 1899. Since 1905 has had chronic indigestion, hunger pains, occasional severe pain in epigastric area after eating, with more or less soreness in appendicular region.

Röntgenologic Diagnosis.—No evidence of new growth or indurated ulcer of the stomach or duodenum can be detected. The contraction of the cap and the extreme pyloric end of the stomach is probably due to a spasm or possibly to adhesions. The flattening of the left side of the ascending colon, the incomplete distention of the cæcum, the insufficiency of the ileocæcal valve, with the distended coils of small intestine pressing on the left side of the ascending colon up to the region of the gall-bladder, are sufficient to cause the spasm of the stomach and cap.

Surgical Findings.—The stomach and duodenum were normal. Two small adhesions passed from the summit of the gall-bladder and duodenum to the liver. An adherent, thickened and angulated appendix was removed.

CASE XXVI.—*Clinical History.*—N. R.; woman; age twenty. Six months ago the patient first began to complain of pain in epigastrium, coming on 2 or 3 hours after meals, gnawing in

character and relieved by taking food or bicarbonate of soda. Three months later the pain began to be associated with attacks of vomiting, which relieved the pain. Vomitus consisted of food recently taken, and twice contained a little blood. Four months after onset of symptoms, patient entered hospital and was treated for 3 weeks with a diet. Diagnosis: Gastric ulcer. After leaving hospital, was free from pain until a week ago, when it returned with occasional vomiting. Loss of 16 pounds in last 6 months. Gastric analysis: Free HCl, 17; total, 36; no lactic acid or blood.

Röntgenologic Diagnosis.—The röntgenographic findings justify a negative diagnosis of new growth or indurated ulcer of the stomach or duodenum. That there is an extreme functional derangement of the stomach is evident from the erratic motor phenomena. When the food was first administered there was a great atony, and no evidence of peristalsis. A few minutes later the peristalsis became hyperactive, and the food was rapidly expelled through a wide open pylorus for a short time, and progressed at great speed through the cap, duodenum and into the jejunum. The 2½-hour röntgenograms show that the stomach is perfectly normal in position, and the cap well distended. But there is no evidence of any food passing through the duodenum or jejunum. In the 5¼ röntgenograms, a moderate gastric retention is seen, with no evidence of the pars pylorica, cap, duodenum, or jejunum. I am unable to determine the cause of this functional disturbance.

Surgical Findings.—The stomach, duodenum and gall-bladder were found to be normal. A thickened and congested appendix, containing a large amount of fecal matter, was removed.

CASE XXVII.—*Clinical History.*—S. B.; woman. For the past 3 weeks patient has complained of almost constant epigastric pain, eructations and nausea. On the day before admission she had an attack of severe pain, radiating to the side and back. The pain has no relation to eating and is relieved by vomiting, which occurs frequently. The vomitus is usually small in amount, greenish and occasionally blood streaked. The patient has never been jaundiced. She believes she has lost some weight. Gastric analysis: Free HCl, 0; total, 26; lactic acid, 0. Blood positive. Blood analysis: Hæmoglobin, 80 per cent.; red blood cells, 5,000,000; white blood cells, 12,000.

Röntgenologic Diagnosis.—There is evidence of an organic hour-glass constriction, with a pouching or perforated ulcer on the lesser curvature, or perhaps a double constriction. Personally, I have seen these lesions occur in unquestionable cases of carcinoma, and I am therefore not prepared to state that it is indicative of a non-malignant condition.

Surgical Findings.—On operation it was discovered that the entire central area of the stomach was distorted by a massive carcinomatous induration, extending from the lesser curvature to the greater, more marked on the posterior surface, in which situation the induration also extended to the pancreas. This resulted in an hour-glass contraction of the stomach, the upper segment of which was concealed beneath the costal border. The lower pouch lay in its normal position. It was impossible to do a gastro-enterostomy with the upper pouch on account of its high position. A gastrogastrostomy was therefore made on the anterior surface of the stomach by the suture method.

In summing up the evidence furnished by this series of 27 cases, it will be seen that of the 22 cases in which a definite diagnosis was made by the Röntgen method, subsequent operation proved that in 20 instances this diagnosis was correct, and in 2 it was incorrect. In 11 of these cases the diagnosis was a negative one regarding the presence of a gastric or duodenal lesion, although the clinical history so strongly suggested ulcer or carcinoma as to justify exploratory operation. In not one of these cases was an organic lesion found to exist. In the 5 instances in which the röntgenologic diagnosis was not definitely stated, owing to incomplete observation, or unusual findings which could not be definitely interpreted, and concerning which only an opinion was expressed as to the probable lesion present, the opinion proved to be correct in 4 instances and incorrect in one instance. In other words, in this particular series, a correct diagnosis was made by serial röntgenography in 89 per cent. of the cases. The information obtained from this series has been invaluable to the röntgenologist in his interpretation of unusual findings, and the experience gained from the hearty coöperation of the surgeon will greatly increase the accuracy of this method of examination.

The objections to the method are obvious. It requires considerable time and is moderately expensive. If it could be shown that a simpler method would give equally good results, that method would undoubtedly become the popular one. In the opinion of the writers, however, serial röntgenography will give more accurate information concerning lesions of the stomach and duodenum than any other method now employed.