**The diagnosis of post-pyloric (duodenal) ulcer by means of serial radiography / by Lewis Gregory Cole.**

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# THE DIAGNOSIS OF POST-PYLORIC (DUODENAL) ULCER

## BY MEANS OF SERIAL RADIOGRAPHY

BY LEWIS GREGORY COLE, M.D.

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CORNELL UNIVERSITY MEDICAL COLLEGE


*Reprinted from THE LANCET, May 2, 1914*

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In previous communications[1] evidence has been assembled to show that the portion of the gastro-intestinal tract, previously called the first or ascending portion of the duodenum, pars superior horizontalis, or "bulbus duodeni," is not part of the duodenum, but really belongs to the stomach, and the name "pilleus ventriculi" (cap of the stomach) has been applied to it. Therefore the term post-pyloric ulcer, or ulcer of the cap, should be substituted for "duodenal ulcer," and will be used herein except in quotations. The diagnosis of post-pyloric ulcer and its differentiation from and relation to malignant and non-malignant lesions of the stomach form one of the firing lines of surgical advance. The importance of this field of work is evidenced by the communications of Wier, Moynihan, Codman, Mayo, and others, who have adequately described the clinical and surgical aspects of the subject.

* This article was read before the XVIIth International Congress of Medicine in London, 1913.

[1] Archives of the Roentgen Ray, April, 1912, No. 141, p. 427; Journal of the American Medical Association, Nov. 30th, 1912, vol. lix., p. 1947; and 1913 Meeting of the American Medical Association, Minneapolis.

Considering the part that radiology has played in medical and surgical diagnosis, it is appropriate that serial radiography should be an active scout in the detection of ulcers of the cap. Communications having a direct or indirect bearing on the radiographic diagnosis of gastric and duodenal ulcers have been published by Hemmeter, Holzknecht, Schwartz, Ashbury, Haudek, Strauss, Kreuzfuch, and Pfahler. Two diagnostic methods have been employed. One is based on symptom-complices, or groups of clinical manifestations, some of which are recognised by fluoroscopy or radiography. But they are symptoms only, as the name suggests, and not direct evidence of the lesion. The other method depends on the contention that bismuth will adhere to the surface of an ulcer or lodge in its crater. Failure to differentiate such flecks from retention in the normal cap is the weak point in this theory. Haudek's "niche" is a finding of undoubted significance. But it very frequently occurs in extensive inoperable carcinoma of the lesser curvature, and furthermore must be carefully differentiated from a small deposit in a pouch of the œsophagus near the cardia.

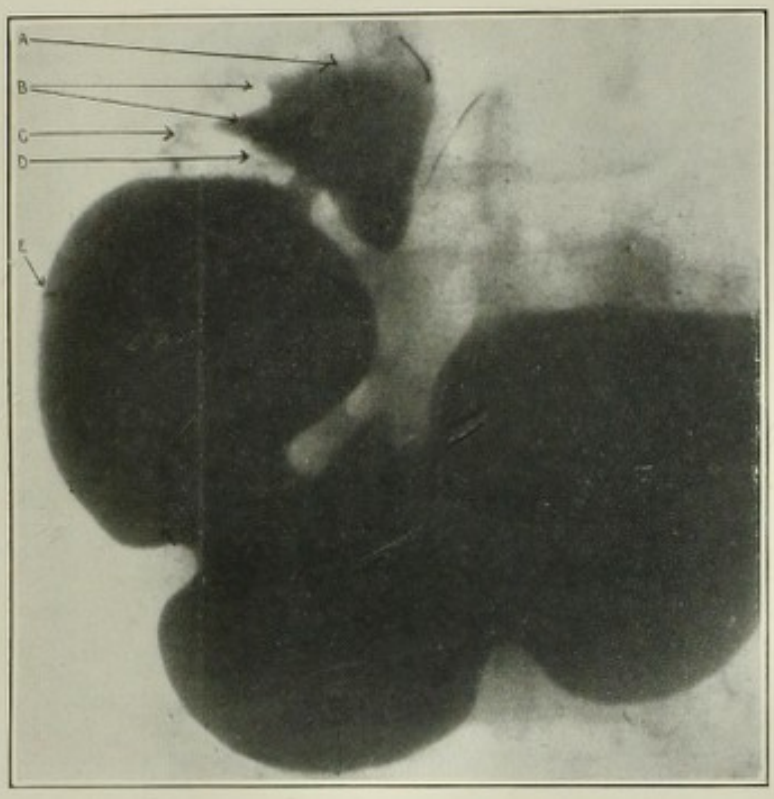
Strauss's excellent article on duodenal ulcer[2] covers many of my observations, some of which have been published, but certain of his deductions do not correspond with my interpretation of the phenomena presented.[3] He bases the diagnosis of ulcer on a rather elaborate symptom-complex

[2] Fort. a. d. Geb. Roentgenstrahlen, 1913, Band xix., H. 6, S. 461.

[3] Archives of the Roentgen Ray, October, 1912, No. 147, p. 172; Journal of the American Medical Association, Nov. 30th, 1912, vol. lix., pp. 1947-51.

which he has compiled. Strauss's remark that roentgen-kinematography may sometime prove of great diagnostic assistance brings me to the crux of my communication.

FIG. 1.




Normal cap and sphincter. A, Cap. B, Indentation of cap by descending duodenum. C, Descending duodenum. D, Pyloric sphincter. E, Terminal wave.

The technique of serial radiography, and especially the relative value of serial radiography and roentgen-kinematography, have been fully explained heretofore. The gist of it is that 24 instantaneous radiographs of different phases of different cycles, made in rapid succession, are of more diagnostic value than 24 radiographs of different phases of one cycle. Technique aside, we pass at once to a description of the anatomy and physiology of the

pars pylorica, pyloric sphincter, and pilleus ventriculi as observed by means of serial radiography. This subject was fully discussed before the American Medical Association in a paper which is now at press.[4]

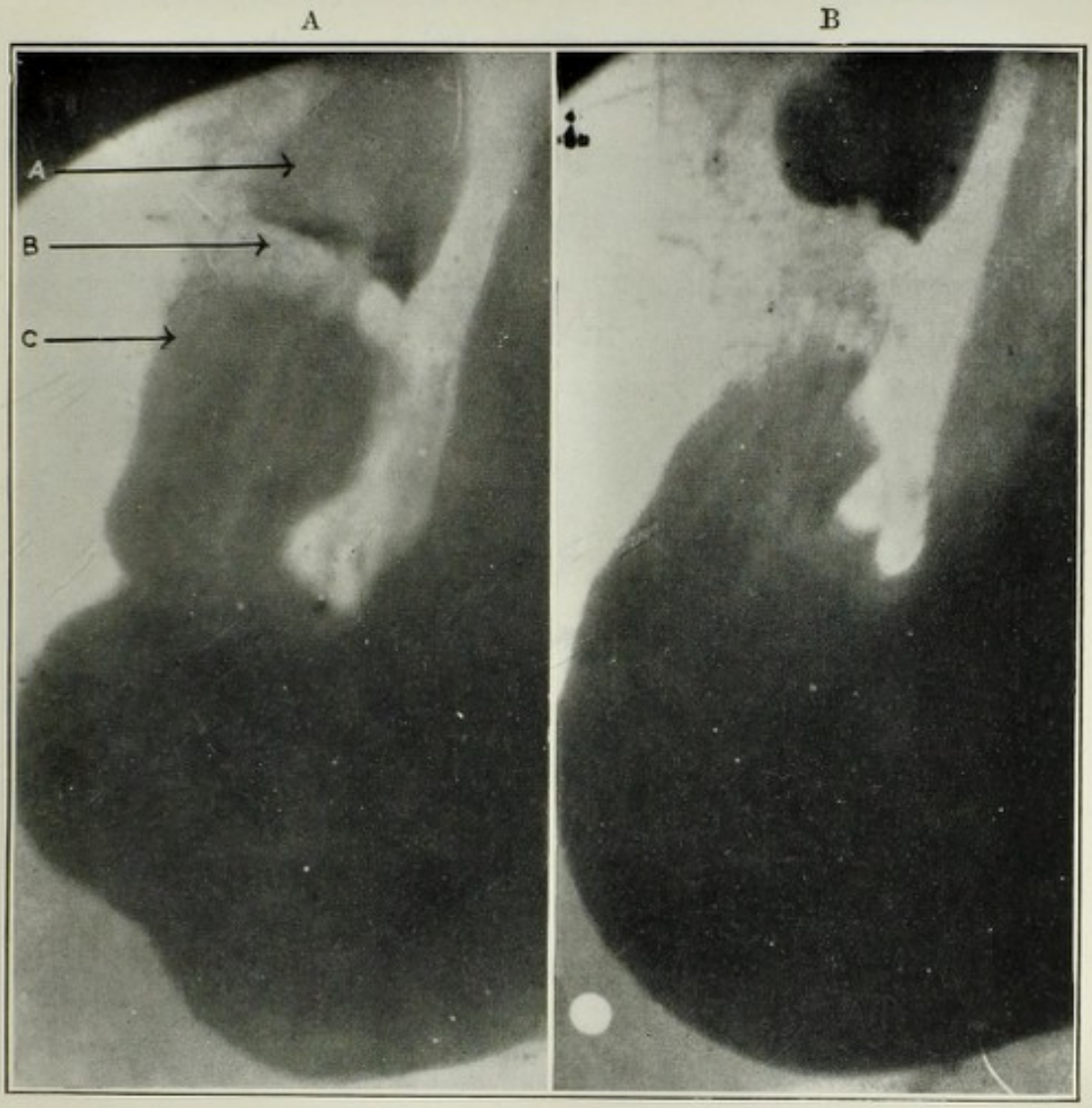
FIG. 2.


Normal cap. A, Cap. B, Sphincter. C, Lumen of sphincter. D, Congenital fold. E, Terminal wave.

The progression of the gastric peristalsis observed by Cannon in the cat[5] was demonstrated in man by Kaestle, Rieder, and Rosenthal.[6] While the progress of the peristalsis may be seen in nearly all cases, the speaker recognises and has previously described a much more complicated gastric motor phenomenon, which, like the heart action, takes place in cycles, marked by a systole and diastole, or a contraction and relaxation of all the peristaltic waves simul-

[4] 1913 Meeting of the American Medical Association, Minneapolis.
[5] Wisconsin Medical Journal, No. 5, October, 1908.
[6] Archives of the Roentgen Ray, No. 119, June, 1910.

FIG. 3.




A, Systole. B, Diastole.

A, Cap. B, Sphincter. C, Terminal wave

taneously. A cycle exists during the time occupied by the formation of each terminal wave or antrum. During the stage of systole (Fig. 3A), which consumes about seven-tenths of the gastric cycle,

FIG. 4


Post-pyloric (duodenal) ulcer. A, Induration from ulcer. B, "Pouch." C, Sphincter. D, Terminal wave.

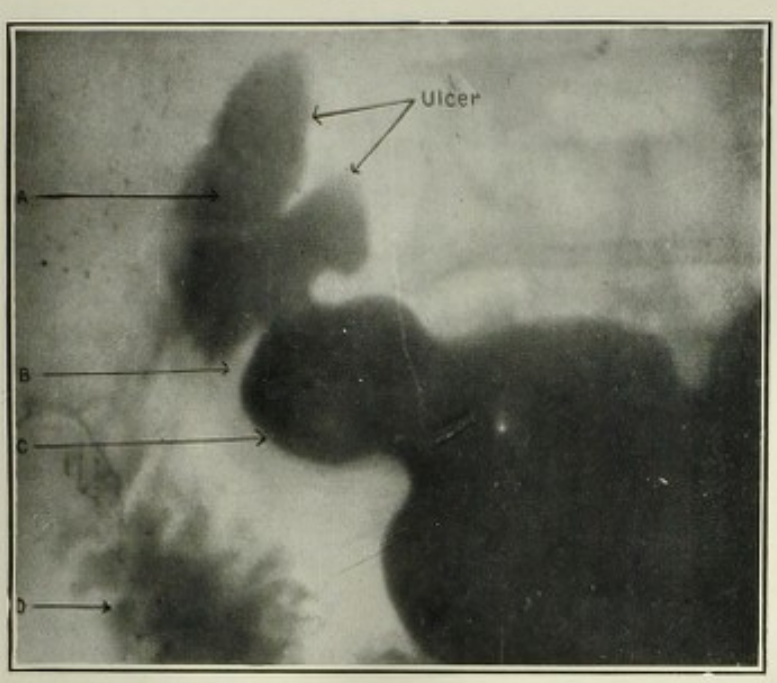
chyme is expelled through the lumen of the pyloric sphincter into the pilleus ventriculi. The remaining three-tenths of the cycle are consumed by diastole (Fig. 3B) when the pyloric sphincter closes and prevents the chyme in the cap from dropping back into the stomach. Sometimes the chyme in the stomach drops away from the pyloric sphincter. The Physiology of the Pylorus, Pilleus Ventriculi, and Duodenum was discussed in a paper before the American Medical Association, June, 1913.[7] There is no evidence of a periodical opening and closing of

[7] Journal of the American Medical Association, Sept. 6th, 1913.

the pyloric sphincter independent of the gastric cycle.

The radiographic evidence that all the characteristics of the cap are gastric rather than duodenal is

FIG. 5

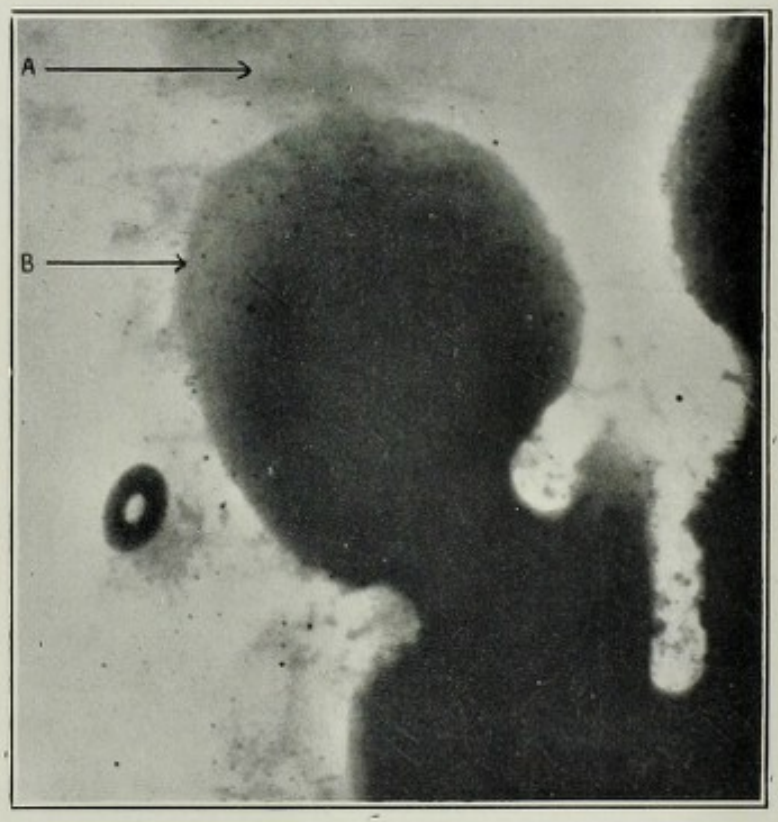



Ulcer of cap (duodenal). A, Cap. B, Sphincter. C, Terminal wave. D, Descending duodenum.

corroborated by embryology, anatomy, physiology, histology, and surgery. The cap (Figs. 1, 2, 3A and B) corresponds in diameter and contour with the pars pylorica. Its dimensions, like those of the stomach, depend partly upon its distension during different stages of digestion, different phases of the cycle, and different stages of duodenal peristalsis. The cap acts as a reservoir, where the finishing touches of gastric digestion may be applied to the small amount of chyme, thus isolated from the bulk of food in the stomach. A space varying from $\frac{1}{8}$ inch to $\frac{1}{4}$ inch, indicating the pyloric sphincter,

separates the cap from the stomach. The lumen of the sphincter is centrally located, and at first about $\frac{1}{8}$ inch in diameter during systole. As digestion proceeds, it gradually relaxes until,

FIG. 6.



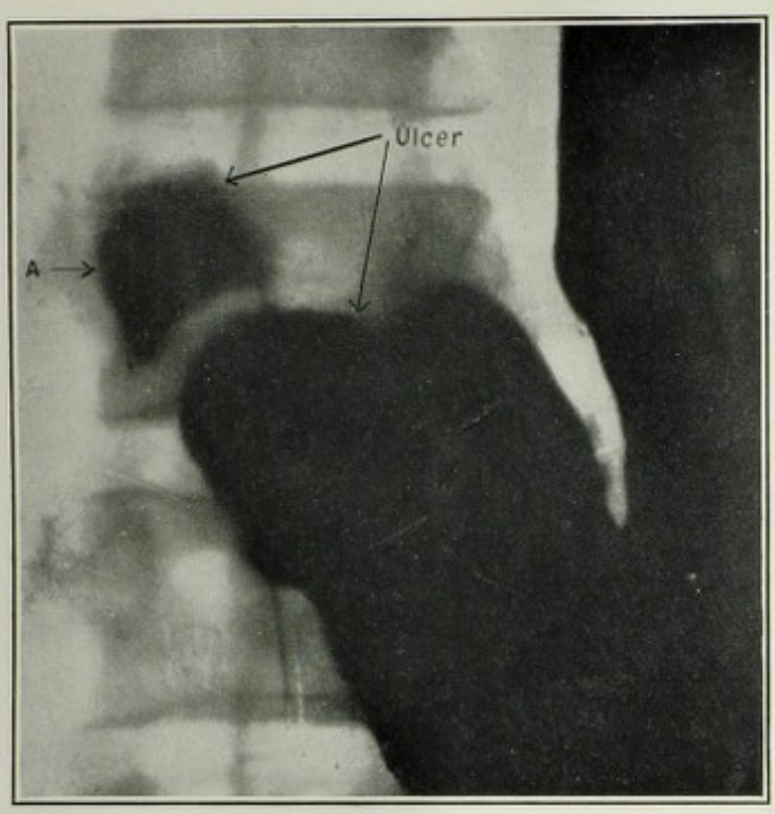

Complete destruction of cap shown at A. B, Terminal wave (antrum).

during the later stages, it is twice as large as at first. The cap is evacuated by a periodical propulsive peristalsis, which propels the chyme through the descending and horizontal duodenum (in the finger-like masses described by Holzknecht).

The method of diagnosing post-pyloric ulcer employed by the author in 500 cases is based on the recognition by means of serial radiography of a constant deformity of the cap or sphincter, caused

by the induration or cicatricial contraction surrounding the crater of an ulcer, or resulting therefrom. These findings are of extraordinary value if the radiographs of a large series are studied indi-

FIG. 7.



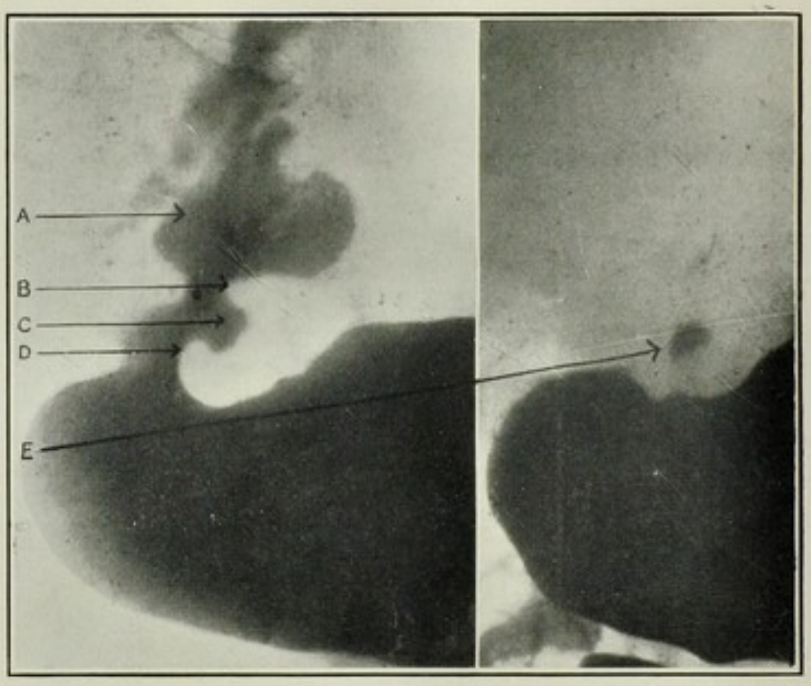

Old ulcer with cicatricial contraction of cap. A, Uninvolved part of cap.

vidually and collectively, and matched over each other or reproduced kinematographically. On the other hand, attempts to apply these diagnostic points to a study of two or three or even a dozen radiographs will only lead to errors and thus reflect discredit on the method. To illustrate the detail necessary for diagnosis, a slide of one characteristic radiograph of each series will be shown. A few series have been reproduced kinematographically to

demonstrate the permanency of such deformity of the cap and sphincter.

The induration of an ulcer projects into the lumen of the cap, causing a displacement of bismuth

FIG. 8.



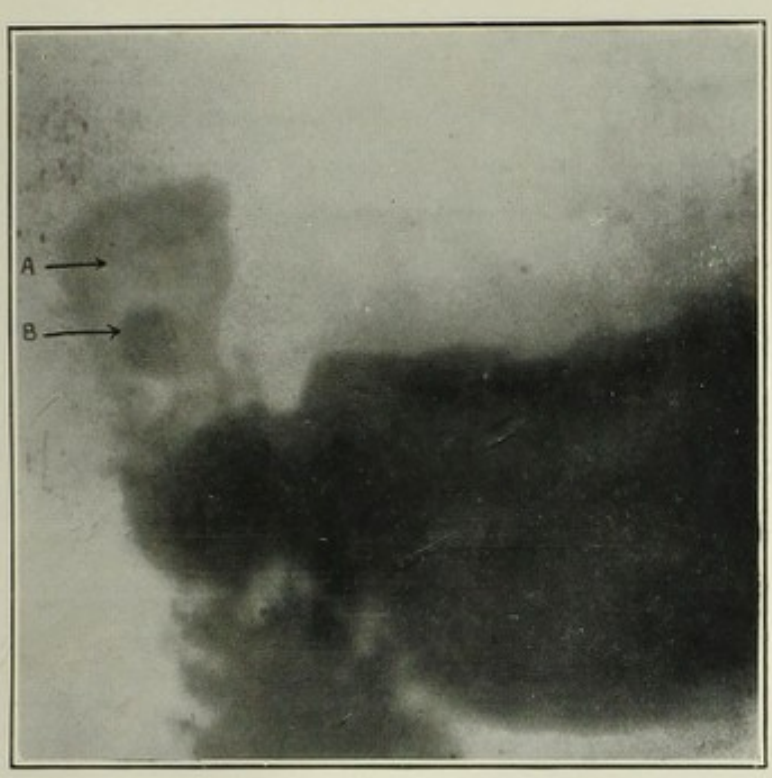

Profile of ulcer. A, Cap. B, Everted edges of ulcer. C, Crater of ulcer. D, Everted edge of ulcer. E, Fleck of bismuth in crater of ulcer.

as constant as one's finger-prints in a ball of putty. (Fig. 4.) It may be so small as to present only a constant dent on side of the cap (Fig. 5), or it may be so extensive as to distort the lumen of the cap beyond recognition. The process may involve one-half of the cap without distorting the other half. (Fig. 7.) In such a case the entrance of the lumen of the pyloric sphincter is an important guide in determining the centre of the cap.

In some instances the ulcer is viewed in profile, so that one sees its indurated edges projecting into

the intestinal lumen and its crater filled with bismuth. (Fig. 8.) Retention in this "bullet-hole" pocket may be differentiated from the pouching to be described later, and from a normal accumulation

FIG. 9.




Ulcer on anterior wall of cap seen "full face." A, Deformed cap. B, Crater of ulcer.

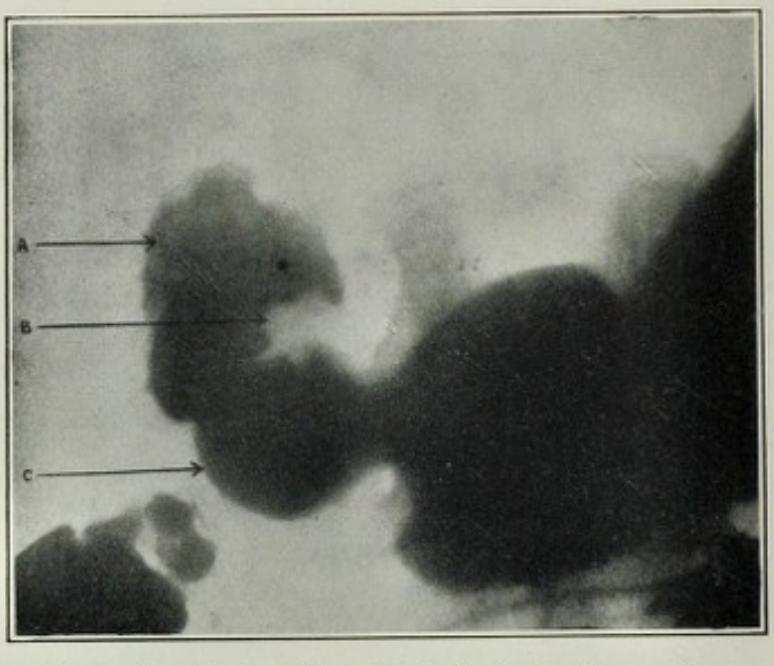
in the cap. In another location the bullet-hole crater may be observed "full face" through the distorted and contracted cap. (Fig. 9.)

Moynihan states that the ulcer may be separated from the pylorus "by a healthy margin of bowel."[8] (Fig. 5.) When this occurs the pyloric sphincter has the normal appearance previously described, and the small margin of healthy bowel is distinctly visible in some of the radiographs. In other cases

[8] Duodenal Ulcer, 1912, Moynihan.

where the ulcer is "just to one side of the pyloric ring, and may involve it" (Codman [9]) (Fig. 10), one side of the pylorus is the width of the indurated ulcer, plus the thickness of the sphincter, while the

FIG. 10.



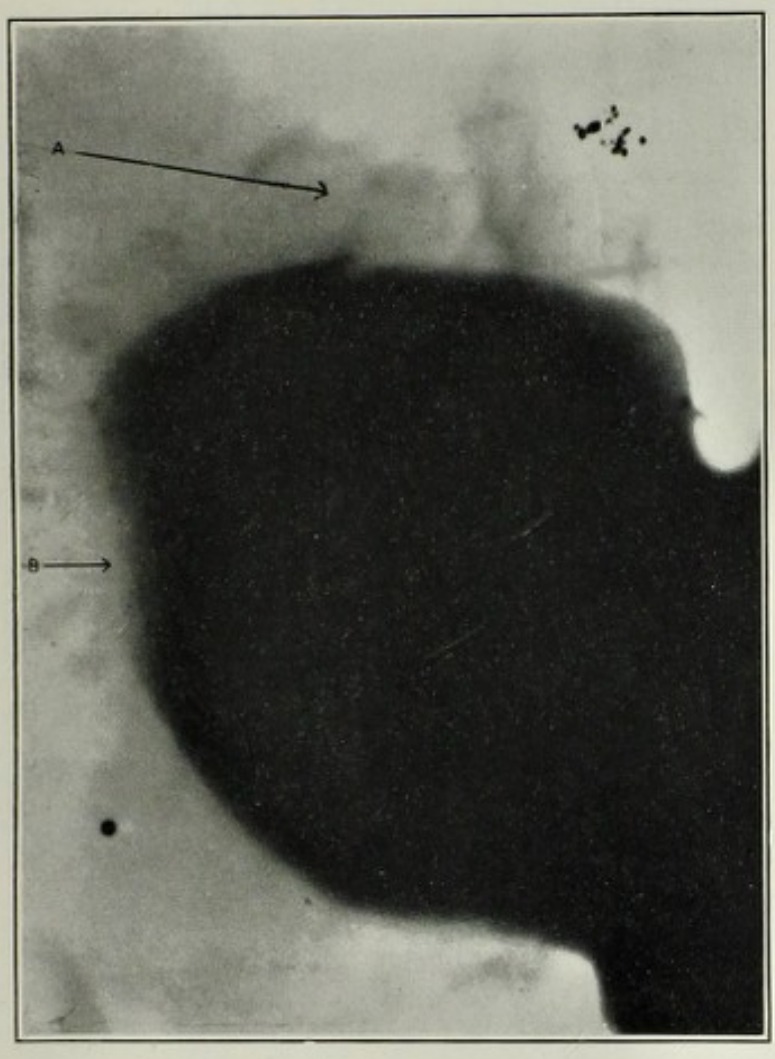

Ulcer of sphincter without pyloric obstruction. A, Cap. B, Ulcer. C, Terminal wave (antrum).

other side has a perfectly normal appearance. The induration may be sufficient to cause an obstruction and dilatation of the stomach; but when the ulcer heals after a gastro-enterostomy the induration subsides, and the chyme renews its passage through the duodenum. Where "the cicatricial contraction results in a formidable narrowing of the lumen of the gut" (Moynihan) (Fig. 11), it is doubtful if the course through the duodenum would be re-established after a gastro-enterostomy.

[9] On the Importance of Distinguishing Simple Round Ulcers of the Duodenum from those Ulcers which Involve the Pylorus or are Above It (1909).

The puckering from the cicatricial contraction may cause a deformity equally as great as the

FIG. 11.

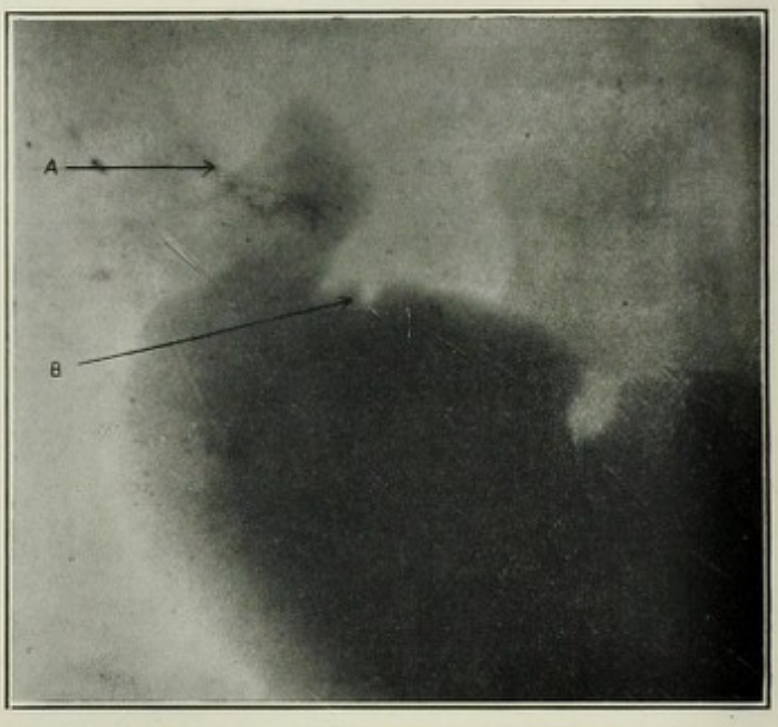



Ulcer of the cap with pyloric obstruction and prognathian dilatation. A, Complete destruction of cap. B, Prognathian dilatation from pyloric obstruction.

induration. (Fig. 11.) Indeed, it is doubtful if one can determine radiographically whether the deformity is due to induration or adhesions, or which predominates. Frequently one observes, in addition to the deformity of the cap, a band of

adhesions passing over on the gastric side of the sphincter, distorting the contour of the extreme pyloric end of the stomach. (Fig. 12.) This manifests itself most frequently by a fold on the lesser

FIG. 12.



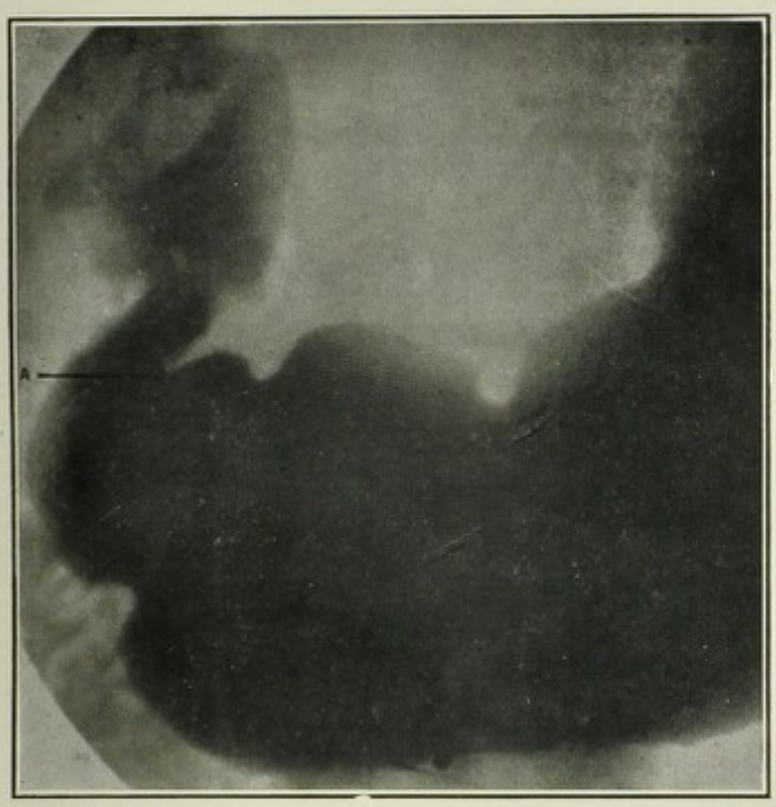

Ulcer of cap with adhesions to lesser curvature of stomach.
A, Ulcer. B, Adhesions.

curvature about half an inch from the sphincter. I have observed this fold in all degrees, sometimes as a slight crease, which I interpreted as a congenital lack of expansion of the gastric wall at this point (Fig. 2), caused by the attachment of the gastro-hepatic ligament; at other times it is of pathological origin, and so extensive as to cause pyloric obstruction. This gives a peculiar form to the stomach, resembling an early fœtus. (Fig. 13.) I think this is what some observers refer to as a

"snail-stomach," although that term is usually associated with gastric malignancy.

The "pouching," described by Moynihan as "a piece of the duodenal wall, which seems almost

FIG. 13.

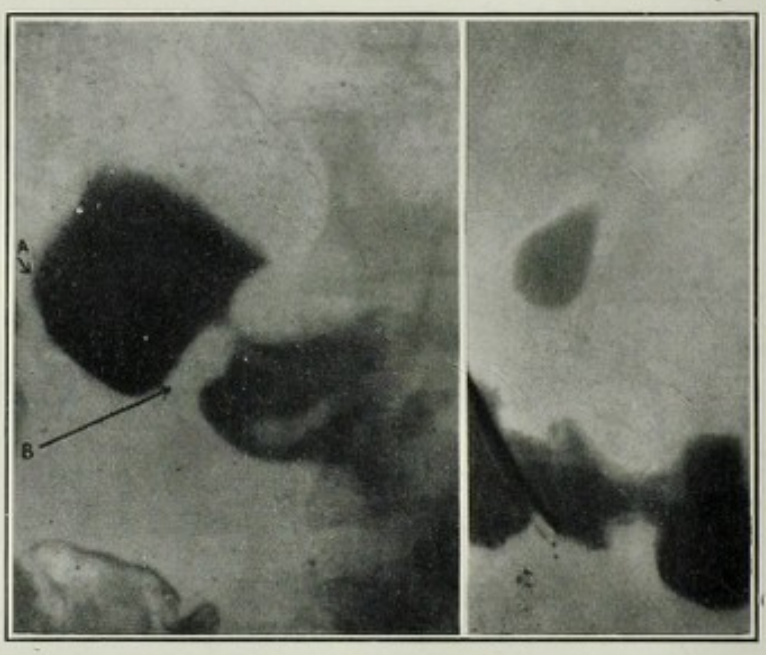



Pathological fold (A) on lesser curvature near pylorus, caused by adhesions.

separated from the rest, being pinched away from it" (Fig. 4), is most interesting. Even his wording describes the radiographic findings in a manner that I cannot improve upon. I have always referred to it radiographically as a distension of the uninvolved portion of the cap. Possibly some of the "flecks" of bismuth which Kreuzfuch supposed were in the craters of ulcers may have been in some instances accumulations in these pouches. If

the pouch is on the under surface of the cap and rather large its bismuth shadow is likely to persist longer than that of the normal cap. (Fig. 15.) Therefore the continued presence here of bismuth

FIG. 14. FIG. 15.




Six-hour retention in normal cap. A, Cap. B, Sphincter.

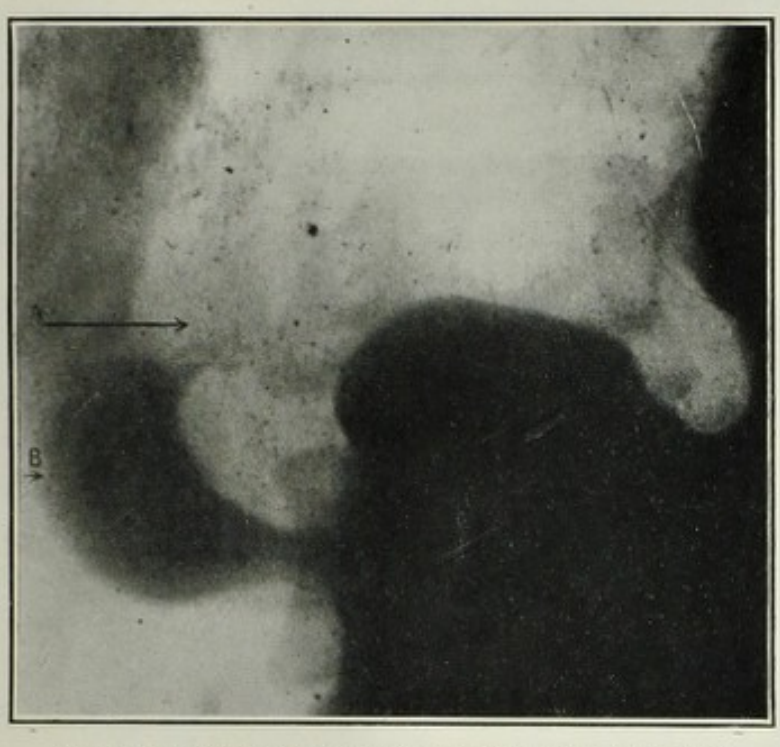
Six-hour retention in pouch.

for an extended period is an additional indication of duodenal adhesions. In many normal cases, however, the cap is filled or even distended at a certain period after ingestion while the stomach is empty. (Fig. 14.) Failure to recognise and differentiate this phenomenon from pouching or a "bullet-hole" crater has led to many erroneous diagnoses of pre- and post-pyloric ulcers, based on the contention that bismuth adheres to the surface of the ulcer.

Narrowing of the lumen by massive deposits of lymph, or by firm contractions of the scar of an

ulcer which has healed, described by Moynihan, could certainly be shown by serial radiography. In some cases this is associated with rapid evacuation of the stomach, but when this reaches such a stage

FIG. 16.




Ulcer with cicatricial contraction and pyloric obstruction.
A, Destruction of cap. B, Terminal wave.

that the lumen is less than that of the pyloric sphincter, gastric retention begins, usually associated with active peristalsis. (Fig. 16.) The degree of gastric retention requiring surgical interference is an open question. Holzknecht considers a six-hour retention abnormal, while Moynihan defines a 12-hour stasis as indicative of surgical intervention.

Many series of radiographs show constant permanent irregularities of the cap that are much smaller

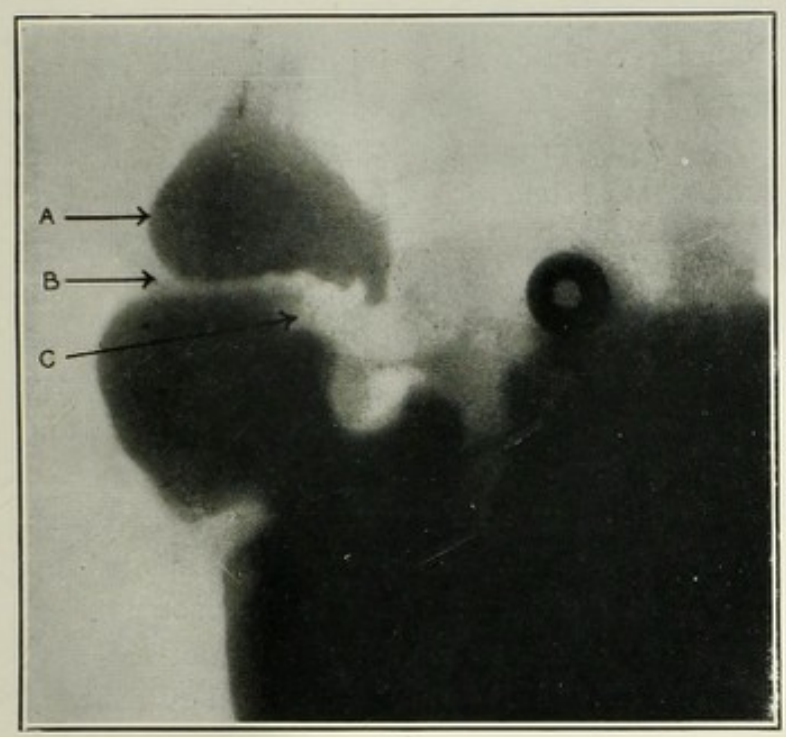
than the pathological lesions previously described. (Fig. 17.) These radiographic findings correspond with Codman's pathological description of healed ulcer, in which a localised area of the muscular coat has been destroyed and replaced by non-elastic connective tissue. Codman acknowledges that such areas are difficult to detect at operation or necropsy, even when a surgeon is looking for them, and I think that these areas correspond with the lesion described by Bloodgood as non-ulcerative lesions in this region. The frequency with which they are recognised radiographically corroborates Codman's contention that ulcers of the cap occur much more frequently than one suspects. And it also indicates the frequency with which ulcers heal without surgical interference. The clinical history must be considered in determining whether these slight, constant deformities are sufficiently extensive to require surgical interference or even to be observed surgically, especially if the surgeon is adverse to the diagnosis of post-pyloric ulcer, and is looking for an appendix, Lane's kink, or something else.

A spasm of the cap, associated with appendicitis, Lane's kink, renal calculi or gall-stones, resembles the distortion from post-pyloric ulcer, except that the spasm varies in appearance, and is absent in one or more of the 40 or 50 radiographs of the series. It can usually be completely relieved by administering belladonna before the confirmatory examination, with the result that a normal cap and sphincter presents. Such functional disturbances must be carefully differentiated from organic lesions of the cap. If one radiograph out of 50 shows a perfectly

symmetrical cap, and a normal pyloric sphincter, a negative diagnosis of post-pyloric ulcer is justified.

A positive differentiation between post-pyloric ulcer and adhesions of the cap from gall-bladder

FIG. 17




Small ulcer of sphincter. A, Cap. B, Sphincter. C, Small ulcer.

infection cannot always be made exclusively from the radiographic findings. Gall-bladder infection usually presents a more extensive involvement of the pylorus and cap. It may involve the greater curvature and draw the stomach to the right, causing an angulation of the cap. The cap may be involved in the adhesions, but not more so than the pyloric end of the stomach, and there is no evidence of a localised area of induration of the cap, nor is obstruction of its lumen so frequent. This differential diagnosis between post-pyloric ulcer and

gall-bladder infection is of more scientific interest than practical value, because in either of these conditions surgery is indicated, if the lesion is sufficiently extensive and associated with symptoms.

Adhesions from post-pyloric ulcer may involve other organs, the hepatic flexure of the colon, the stomach or the duodeno-jejunal junction, where the lower end of the C-shaped duodenum lies in close proximity to the cap. Sometimes the symptoms of adhesions of the colon are more marked than those of the ulcer itself, and lead to a radiographic examination of the colon rather than of the stomach. It is therefore wise in all cases of adhesions of the hepatic flexure and first portion of the transverse colon to make a radiographic examination of the stomach and duodenum. When adhesions from an ulcer of the cap involve and obstruct the lower end of the C-shaped duodenum, there is an unusual dilatation of the descending and horizontal portions, causing the sausage-shaped duodenum, referred to by Holzknecht. This sausage-shaped appearance is not necessarily an indication of ulcer of the cap, as it is more likely to present in cases of chronic obstruction of the duodenum by the root of the mesentery, a condition described by Codman. The same obstruction at the duodeno-jejunal junction may also be caused by ulcers on the posterior wall of the stomach.

By the use of serial radiography, previously described by the present author, George (Boston) has been able to diagnose post-pyloric ulcers with a degree of certainty equal to that of the work herein reported. The procedure may seem very elaborate and therefore expensive, but considering

the obscurity of these lesions, and the fact that the negative or positive diagnosis of post-pyloric ulcer by serial radiography is equally as accurate as the radiographic diagnosis of renal or ureteral calculus, one is justified in expending an unlimited amount of energy in detecting this lesion and differentiating it from other lesions.

This article has dealt solely with the *method* of diagnosing post-pyloric ulcer, and with one or two exceptions all of the cases illustrated have been proven by surgical procedure. Lack of space has necessitated the omission of many other proven cases of equal interest.

New York.

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