ROENTGENOLOGIC DIAGNOSIS OF NEOPLASTIC DISEASES OF THE STOMACH

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In 1899, only four years after Roentgen's discovery, Francis H. Williams, assisted by Walter B. Cannon, examined, by means of roentgen rays, the stomachs of two children who had been given bismuth meals. The observations, which were described in detail in Williams' book, pertained chiefly to variations in size, form, and position of the stomach during the process of digestion, but in his final comment Williams made a significant prophecy. He predicted that after the various characteristics of the normal stomach had been established, abnormal conditions would be more readily recognized by this method. "The constant presence of a darkened area in the stomach," he said, "may suggest thickening of its walls due to malignant disease." Thus he foresaw clearly that a tumor would protrude into the gastric lumen and produce a defect in the shadowed contour; this was the filling defect which was later to become the basic factor in the diagnosis of all gastric neoplasms. But it was not until long afterward that his prediction was fulfilled, and then the roentgenologic diagnosis of organic diseases of the stomach, including the new growths, was swiftly developed to the point at which the law of diminishing returns bears heavily. Progress is now obliged to take the form of more thorough application of old principles, the evolution of minor improvements in technic, and the development of greater skill in interpretation through experience. By such means, however, the knowledge of benign gastric tumors has been substantially enlarged, and malignant growths are discovered earlier now than formerly.

Statistics indicate that benign new growths constitute less than 2 per cent of gastric neoplasms. Most common among the non-malignant tumors are the mucous polyps, adenomas, papillomas, myomas, fibromas, and hemangiomas; less often encountered are the myxomas, lipomas, osteomas, chondromas, teratomas, and cysts. Despite their varied histologic characteristics, and the

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inevitable exceptions, they have many characteristics in common. As a rule they are relatively small, with a diameter of only a few centimeters. Single tumors preponderate in reports of cases, but they are often multiple and sometimes numerous. Only rarely do they project outside the stomach. A large majority are intraventricular, and they are situated most often in the pyloric half of the stomach. More commonly they are pedunculated, but occasionally they are sessile. They are usually ovoid and have a

![Fig. 1](image1.png)  ![Fig. 2](image2.png)

**Fig. 1.** A Small Central Defect Typical of a Benign Polypoid Tumor near the Pyloric End of the Stomach

In the illustration the defect on the greater curvature was produced by the pressure of the spine. At operation an adenomatous polyp, 2 by 1 cm., was found.

**Fig. 2.** A Small Rounded Central Defect above the Angle of the Stomach, Indicated by the Arrow

The roentgenologic diagnosis of a pedunculated benign tumor was substantiated surgically.

smooth surface; exceptionally they are compound and multilobular. Although subject to erosion and superficial ulceration, they are seldom deeply ulcerated. Notwithstanding their primary benignancy, many of them, especially the papillomas and adenomas, undergo malignant change, or are found in association with carcinoma.

The term gastric polyposis is sometimes loosely applied to various endogastric tumors, whether single or multiple, benign or
malignant. Preferably it should be restricted to multiple, primarily benign polyps, produced by hyperplasia of most or all of the mucosal elements, the polyadenomes polypeux and the polyadenomes en nappe described by Menetrier. In the group first mentioned, the polyps are discrete, and consist largely of hyperplastic glands. In the second group, cases of which are rare, the polyps arise from a common, thickened base, are closely packed in orderly rows which resemble the convolutions of the brain, and the glands, although elongated, are not hypertrophic. Inasmuch as the second variety differs from the first in incidence, gross appearance, and histologic structure, Broders is of the opinion that it should be regarded as a separate pathologic entity.

Roentgenologically, the exogastric growths usually, either by traction or pressure on the gastric wall, produce a local marginal deformity of the barium shadow; this is likely to be attributed to ulcer or cancer. The endogastric tumors, on the other hand, produce more distinctive manifestations. In general, the defects corresponding to the growths are regularly oval or hemispherical, and are situated within the gastric shadow, the normal contour of which is preserved (Figs. 1 and 2). Broadly sessile or closely packed growths intrude into the gastric profile, of course, but they are not common. Because the tumors ordinarily are small they are seldom palpable. Those which have long pedicles can be displaced by manual pressure over the stomach, but return to their former position when manipulation ceases. In occasional instances a pedunculated growth near the pylorus prolapses into the duodenal bulb and produces a characteristic rounded defect within the bulbar shadow. Most of these neoplasms have their origin in the mucosa and do not affect the muscularis propria; consequently the wall remains flexible throughout and peristalsis is not altered. Although the masses necessarily reduce the gastric capacity in proportion to their bulk, the size of the stomach is not otherwise diminished. Finally, a significant feature of benign tumors is the complete absence of spastic contraction or any form of gastrospasm.

Thus the traits of benign tumors are so numerous, definite, and distinctive that they should seldom be misinterpreted. Remnants of food may appear as transradiant areas, but their position is inconstant. A lobulated adenocarcinoma may resemble a compound benign polyp, but both are rare. Diffuse polyposis, especially Menetrier's second variety, presents such a characteristic picture that it can scarcely be mistaken for that of any other disease
Nevertheless, roentgenologic signs of benign neoplasms are fairly dependable only in respect of primary innocence, and the possibility of malignant change or of the association with carcinoma must be duly considered in determining appropriate treatment.

If gastric carcinoma invariably manifested itself as a frank and persistent tumor, and if the cases were seen only at an advanced stage, the disease would rarely fail to be recognized. The large and irregularly bordered marginal defect representing a gross medullary carcinoma, or the funnel-like deformity produced by an extensive, scirrhouus infiltration, together with a palpable mass or rigidity corresponding to the deformed segment, gaping or obstructed pylorus, and absence of peristalsis from the involved region constitute a roentgenologic syndrome which is virtually pathognomonic. Distortion of the stomach by gas in the bowel, spasm, or a strongly retracted abdomen, no longer deceives the wary examiner. He can identify the deformity resulting from extrinsic tumors by the effect of manipulation and by the fact that...
the rugae are not altered. Scirrhous carcinoma may be imitated by lesions of syphilis, but the latter almost never produces a palpable mass, and the extent of the lesion is out of proportion to the general condition of the patient, who is usually well nourished and not cachectic.

Our experience indicates that sarcoma is likely to be far advanced at the time of discovery and deform the gastric shadow extensively. The majority of published observations call attention to its predilection for the greater curvature, although this is not a uniform finding. The disease is rare, and although unmistakable roentgenologic evidence of the malignant nature of the process usually can be elicited, the roentgenologist is prone, on account of its comparatively low incidence, to designate the process as carcinoma rather than sarcoma (Fig. 4).

Most of the roentgenologic literature and illustrations of gastric carcinoma pertain to the advanced and essentially tumefactive growths, and tend to create the impression that both the discovery and the specific diagnosis of carcinoma are uniformly easy. However, this optimistic view is not warranted, for it takes no account
of small malignant lesions, which are sometimes hard to reveal and more often hard to identify. Practically all gastric lesions present definite roentgenologic evidence of their presence. But to elicit sufficiently distinctive evidence of the malignant or benign nature of the lesion constitutes one of the most trying difficulties which the roentgenologist is asked to face. Chief among the causes responsible for failures of discovery and errors in differential diagnosis are: (1) the factors of infiltration and ulceration in the morphology of

carcinoma, and (2) the frequently identical appearance of small prepyloric lesions which are quite diverse in character.

In its earlier stages evidence of infiltrative carcinoma is exceedingly difficult, sometimes impossible, to reveal. Theoretically, even a relatively slight infiltration should locally efface the rugae by superficial ulceration or submucosal swelling, interfere with peristalsis, and produce visible spastic or organic contraction. However, more than one instance can be cited in which a duly careful

FIG. 5. THICKENING OF THE GASTRIC WALL, WITH CONSEQUENT NARROWING OF THE PYLORIC HALF OF THE STOMACH

On exploration an inoperable carcinoma of the linitis plastica type affecting the entire lesser curvature was found (Fig. 6).

FIG. 6. SAME CASE AS IN FIG. 5, SHOWING PERISTALYSIS PASSING THROUGH THE AFFECTED PORTION
examination failed to disclose any evidence of disease, yet the patient returned a few months later with extensive or inoperable scirrhous carcinoma (Figs. 5 and 6). In this connection it may be recalled that the extent of an infiltrative carcinoma is much greater than that shown by roentgen rays, and, even after making liberal allowance, the examiner is often mistaken as to operability in a given case.

The ulceration to which carcinoma is subject varies from superficial denudation to almost total sloughing, and may help or hinder roentgenologic recognition of the disease. Multiple ulcerous excavations are often the cause of the irregularity which characterizes the internal border of a defect caused by carcinoma and aids in its identification. A crater which has not penetrated beyond the normal confines of the gastric lumen, and which is surrounded by an elevated, overhanging ridge, is pathognomonic of ulcerating carcinoma (Fig. 7). On the other hand, when ulceration so dominates the morphology that no hyperplasia is evident, and the lesion is
essentially and solely an ulcer excavating the gastric wall, distinction from benign ulcer may be difficult or impossible (Fig. 8). Experience has shown that an ulcer represented by a niche more than 3 cm. in diameter is usually malignant, but this criterion is not infallible. Further, it is known that an ulcer manifested as a niche in the gastric wall, with a diameter of 2 cm. or less, and having the macroscopic appearance of a benign ulcer, may prove microscopically to be malignant. Granting that the proportion of such cases is not large, it is nevertheless substantial. As to the roentgenologic similarity of small prepyloric lesions which are different in nature, extended argument is unnecessary. Almost without exception they can be disclosed easily; but syphilis, hypertrophy of the pyloric muscle, and early scirrhouss carcinoma often produce identical deformities (Figs. 9, 10, and 11), malignant tumors may resemble benign new growths, and malignant ulcers may carry no obvious marks of their nature.

In attempting to distinguish malignant from benign ulcer, or to discern differences among the various prepyloric lesions, the slighter
direct manifestations and secondary phenomena may be of assistance. Often the niche of a malignant ulcer is somewhat faintly depicted, irregular as to profile and margin, and situated in a region where the rugae have been effaced. Usually the niche of a simple ulcer is dense, regularly semicircular in profile, roundly margined, and surrounded by accentuated and converging rugae. Malignant ulcer excites little if any spasm, and is likely to be accompanied by sluggish peristalsis and a gaping pylorus. Simple ulcer often gives rise to antral spasm, and is likely to be attended by active peristalsis and a closed pylorus. Ulcers on the posterior wall, or near the pylorus, are more likely to be malignant than those on the lesser curvature near the angle of the stomach. Ulcers on the greater curvature are almost always malignant. A malignant ulcer is seldom tender, and tenderness over a niche suggests that the ulcer is benign. Certain of the features mentioned, notably the condition of the rugae, degree of peristaltic activity, patency of the pylorus, and sensitiveness to pressure, sometimes aid in the differential diagnosis of neoplastic diseases restricted to the vicinity of the pylorus. Such lesions are often obstructive, and it is noteworthy that the re-

Fig. 10  Fig. 11

Fig. 10. Prepyloric Narrowing to Which a Small, Faintly Palpable Mass Corresponded

The mass impended on the bulb and produced irregularity of the bulbar base. A conservative diagnosis of "lesion at the outlet" was made, although the roentgenologist suspected that the lesion was malignant. At operation only marked hypertrophy of the pyloric muscle was found.

Fig. 11. Prepyloric Narrowing Somewhat Resembling that Seen in Fig. 10

However, its proximal confines are more abrupt and irregular, and it corresponded to a definitely palpable mass. The diagnosis of carcinoma was confirmed by exploration.

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resulting dilatation of the stomach is likely to be pronounced when the lesion is benign and slight when the lesion is malignant.

On the basis of the foregoing minor signs, which vary widely in their emphasis and combinations, the roentgenologist is sometimes able to form a correct opinion as to the malignancy or benignancy of the lesion. In many cases of malignant ulcer, however, he is unable to find any indication of the fact and is obliged to assume that it is benign. In other instances the finer marks of malignancy are so few and indistinct that the examiner is constrained to ignore them. The percentage of errors resulting from all causes is not small, and on reviewing his personal statistics the roentgenologist is likely to be surprised at the number of early carcinomas which he overlooked, and of malignant ulcers which he adjudged to be benign.

Granting that errors in the roentgenologic diagnosis of early carcinoma and malignant ulcer cannot be avoided altogether, it is none the less desirable to reduce them further. A thorough realization that gastric carcinoma has a higher incidence than all the benign diseases of the stomach combined might make the roentgenologist somewhat less inclined to err on the side of benignancy. At The Mayo Clinic during 1930 almost three-fourths of the gastric lesions found at operation were malignant. Evidently this proportion was not due principally to the basis of selecting cases for operation, with a preference for those suspected to be malignant, for during the same period about two-thirds of the gastric lesions not subjected to operation were diagnosed as malignant by means of roentgen rays. More active cooperation of the roentgenologist and the clinician would also avert many errors. The indecisive signs and symptoms which are consistently omitted from formal reports should be canvassed in personal conference, and in all doubtful cases the respective examinations should be repeated. Syphilis of the stomach occurs, but it is so rare that any supposed instance should be regarded skeptically, and the allowance of time for therapeutic tests should not be too liberal. The effect of dietetic and medical treatment on gastric ulcers should be determined by roentgenologic examination at relatively short intervals. Finally, the annual health examination, which is increasing in popularity, should always comprise a roentgenologic investigation of the alimentary tract.