Roentgen Pathology of Duodenal Ulcer[1]

Observations in a Tropical Area

By MAJOR MANUEL GUZMÁN

Medical Corps, Antilles Department

THIS PAPER is mainly based on observations gathered during the review and analysis of 4,175 X-ray studies of the gastrointestinal tract performed during the last five years; 2,319 of them were performed by the author during 1943 and 1944 (Charts 1 and 2).

We fully realize that, except for the years 1940 and 1941, the incidence of duodenal ulcer was rather low in our series if compared to the statistics of other military hospitals in England, Germany, and continental United States. We have to acknowledge further that the ratio of duodenal ulcer to gastric ulcer was out of proportion when compared to figures recently published by military and civilian observers. However, this study concerns itself primarily with groups of patients admitted to the hospital directly from a peaceful garrison environment or from the more strenuous life of jungle-training areas. The majority were young soldiers in the second or third decades of life. Before admission, most of them had received the full benefit of judicious treatment for considerable periods of time in general or camp hospitals.

In analyzing the series of gastrointestinal X-ray studies performed during the years 1940, 1941, and 1942, all clinical reports were carefully reviewed in conjunction with the X-rays taken. The 1,302 studies of the year 1943 were analyzed according to a method that is a modification of the system followed by the late Dr. Russell D. Carman,[2] of the Mayo Clinic, and Professor William Meyer,[3] of the New York Post Graduate Medical School.

The 1,017 X-rays corresponding to the year 1944 were studied and analyzed in accordance with a method worked out by us, which reveals at a glance the main fluoroscopic findings, the radiographic report, the fractional analysis of the gastric contents, and a few other salient points about the patient's blood picture. On the reverse side

1. Received for publication April 10, 1945. Lecture delivered at the School of Tropical Medicine, San Juan, Puerto Rico, on March 15, 1945.

2. R. D. Carman, *Roentgen Diagnosis of Diseases of the Alimentary Canal, 2d ed.* (Philadelphia: W. B. Saunders Company, 1920).

3. Notes taken by the author in 1928 and 1934, while pursuing studies in Roentgenology at the New York Post Graduate Medical School.

of the card used for this tabulation, there is ample space for a short clinical history or any additional remarks that may have a bearing on the case. Furthermore, small photographs or ink sketches of the pathological findings may be conveniently attached. The intrinsic value of this method may be easily understood when we say that one and a half years of painstaking labor were spent in the analysis and tabulation of 1,700 gastrointestinal X-ray studies for the years 1940, 1941, and 1942, while 2,300, performed during 1943 and 1944, were studied and analyzed by our method in less than eight weeks' time (Chart 3).

Few of us realize how very recent is the admission of duodenal ulcer as a definite roentgen pathological entity. Although more or less serious attempts have been made since the days of Bucquoy to establish a differential diagnosis of gastric ulcer, it was not until the early part of 1911 that textbooks in medicine began to refer to a more or less accurate diagnosis of this condition. Three years before, in 1908, the surgical clinics of Rochester and Leeds had reported the first four hundred cases, verified on the operating table. There is no doubt that scientific interest was stimulated and aroused by the brilliant work of the Mayos in the United States and Moyniham in England.

In 1914, Cole[4] pointed out that the constant deformity of the bulbar shadow was typical of duodenal ulcer. This contribution may be considered as the beginning of American gastric roentgenology, since it established a different criterion from that stressed by European roentgenologists of that period. Carman, in 1920, laid emphasis on the importance of irritation reflexes, such as gastric hyperperistalsis, colonic hypermotility, and gastric residue as roentgenological signs of duodenal ulcer, even in the absence of bulbar deformity. Carman went as far as grouping together the above reflex signs into sign complexes and asserting that, with them, the diagnosis of duodenal ulcer was conclusive.

In 1928 and again in 1934, Meyer taught his pupils that residue in the pylorus and duodenal bulb, coincident with colonic hypermotility and gastric hypersecretion, might be considered as a safe basis for a diagnosis of duodenal ulcer. From 1910, however, the literature had contained numerous contributions dealing with direct criteria for diagnosing ulcerating lesions, which contrasted with the evidence pointed out by Carman, Meyer, and their followers. It might be well to state here that, though these scientists upheld the irritation

4. L. G. Cole, Diagnosis of postyploric (duodenal ulcer) by means of serial radiography. Lancet, 1:1239–1244, 1914.

reflexes as indirect or corroborating evidence of diagnosis, they accepted the distortion of the bulb as the only direct evidence. During all of this period, 1910 to 1924, Cole valiantly defended bulbar distortion as the sole basis for the diagnosis of duodenal ulcer.

Writing in 1924 about newer concepts in the roentgen interpretation of duodenal ulcer, Diamond[5] considered the niche as the outstanding direct evidence. This was the first contribution on this aspect of roentgen diagnosis published in the United States. Finally, in 1936, Kirklin,[6] of the Mayo Clinic, stated that irritation reflexes, neither singly nor in various combinations, had any valid basis for a diagnosis of duodenal ulcer. His views were supported by such men as Buckstein,[7] Golden,[8] Geyman,[9] and others.

There is so much variation in the gastric irritation reflexes, also called indirect or corroborative signs, in serial examinations of the same patient, and they appear so infrequently in definitely positive cases of ulcerating lesions that their diagnostic value is extremely hypothetical. A careful analysis of these reflexes tends to show that most of them are caused mainly by obstructive lesions. The six-hour residue in the absence of gastric ulcer or cancerous lesions, the compensating hypertonic stomach, and the phenomenon of hyperperistalsis can only be satisfactorily explained by beginning or definite obstruction. Besides their inconsistent appearance in serial X-rays, the main issue against these reflexes is the fact that they are also frequently found in ulcers of the stomach, carcinoma of the antrum, cholecystitis, diseases of the appendix, and pyloric obstructions. Not infrequently, these reflexes are also demonstrable in the absence of disease.

In our series of 4,175 gastrointestinal X-ray studies, wherein 416 cases of duodenal ulcers were reported, colonic hypermotility was a common occurrence in both positive and negative cases. Hyperperistalsis was only observed in 11 cases of duodenal ulcer. Gastric residue in both the pylorus and duodenum was commonly observed in both positive and negative cases, while a 50 percent residue was noted in only one case of duodenal obstructive ulcer. Although very frequently seen, the inconsistent appearance of these symptoms was

5. J. S. Diamond, Newer phases in the roentgen interpretation of duodenal ulcer. Am.J. Roentgenology, 11:317–328, 1924.

6. B. R. Kirklin, quoted in "*The Stomach and Duodenum*," by Eusterman and Balfour (Philadelphia: W. B. Saunders Company, 1936).

7. J. Buckstein, *Peptic Ulcer, 2nd ed.* (New York: Paul B. Hoeber, 1933).

8. R. Golden, *Diagnostic Roentgenology, 1st ed.* (New York: Thomas Nelson & Sons, 1936).

9. M. J. Geyman, Evaluation of compression technique in roentgen demonstration of duodenal lesions. Am. J. Roentgenology, 28:211–222. 1932

properly analyzed in our examinations, as all rechecks were ade after prolonged weeks of treatment.

The distortion of duodenal contour, which may vary from a slight dentation to a wide incisura, or from a minute bulging to a bizarre ojection of outline, usually occurs as an addition to, or a subtraction from, the normal profile of the barium-filled duodenal shadow. Its significance does not depend on size but on constancy. Like other portions of the alimentary canal, the duodenum can be affected by all kinds of spasms originating from causes outside of the digestive tract. This explains why all bulbar deformities are not diagnostic of duodenal ulcer.

Very frequently, in the hypersthenic individual with tense abdominal muscles, the bulb does not fill adequately. With less frequency, adhesions from pericholecystitis, neoplastic lesions in the right upper abdominal quadrant, duodenitis and, more often, periduodenitis, may simulate or may produce identical structural distortion. Occasionally, the pressure of the second lumbar vertebra over the duodenal bulb again produces definite indentation. Very frequently, the valvulae conniventes of the descending portion of the duodenum, seen posteriorly require more than a passing glance and repeated X-rays, taken obliquely and laterally, to rule out the presence of duodenal lesions.

The characteristic features of the so-called normal duodenum, with bee-hive shape, smoothness and symmetry of contour, and flat bulbar base, are not sufficiently consistent to discard the possibility of duodenal ulcer. In fact, these findings appear only faintly on the fluoroscopic screen. In the usual ventrodorsal X-rays, with the patient lying down, abdominal pressure, filling stage, tonus, and position factors very often make the abovementioned characteristics difficult to determine. When X-rays are taken in the standing position, caps of normal contour are often observed. Although these findings may suggest the absence of duodenal lesions, the latter cannot be eliminated on this evidence alone.

When early in 1914 Cole admitted that a normal duodenal bulb, found without any distortion in contour, was equivalent to an absence of lesions, O'Brien[10] asserted that the inverse of the proposition must also be true. Carman recognized at an early date that duodenal ulcer may exist without any distortion of the bulbar shadow, which view was also supported by Kirklin, Diamond, Buckstein, and others.

10. G. L. O'Brien, *Medical Clinics of North America* (Philadelphia: W. B. Saunders, 1917).

Again and again, surgical pathology has demonstrated that, in the most striking cases of duodenal ulcer, the serosa of the bulb is of normal appearance and of normal contour on examination and palpation. In the operating-room, and occasionally, at autopsy, we have been confronted by the fact that, though ulcerating lesions of the duodenum may occur anywhere, the greatest percentage is always found either in the anterior or posterior walls. It has also been generally recognized that evidence of such barium-filled craters is only obtained by disclosing the niche *en face*, yet we have to confess that most observers in this field of roentgenology are under the impression that this last named evidence is of secondary importance only. Most roentgenologists seem to be satisfied with findings other than the niche itself, which in most instances are only crude imitations of structural alterations or distortion of the bulb.

It seems logical that the most relevant evidence of ulcer of the duodenum should be the ulcer itself. If the niche is the roentgenological reproduction of the barium-filled ulcer crater, surrounded by some edema of the mucous coat, nothing else but the niche should assume, whenever feasible, the place of the ulcer.

While discussing the ability to locate superficial ulcers, a group of German observers, Ulrich[11] among them, offered the statement that since the average thickness of the duodenal bulb is around 2 mm., ulcers of only one half a mm. in depth piercing the mucous membrane, would escape detection. This assertion was probably influenced by Clairmont's[12] post mortem studies. However, it is necessary to bear in mind that the depth of the ulcer in a patient is not measured by the crater itself but by the excavation plus the surrounding edema.

Although continental observers recognize the finding of the niche as the only pathognomonic evidence of ulcer, they have never been overly enthusiastic about its necessary demonstration. Some of the outstanding exponents of this theory, such as Kirklin and Buckstein, have advanced the thought that the presence of the niche is equivalent to recognition of ulcer activity. We have to disagree with this statement.

Kirklin further stated that the niche cannot be ordinarily determined in a large percentage of cases, and that its demonstration is not imperative. This seems to be the general opinion of continental

11. K. Ulrich, cited in *Roentgen Diagnóstico*, by Schinz, Baensch, and Friedl, 1st ed. (Barcelona: Editores Salvat, S. A., 1933).

12. *Ibid.*

vestigators. The dissenting voices of Diamond, Bowman,[13] and eyman in 1924, 1930, and 1932 were not heard, neither was the erit of their work properly recognized. It is the opinion of the thor, however, that a clear conception of its roentgen pathology is ecessary for an accurate diagnosis of duodenal ulcer. Besides serv- the purpose of furnishing a logical classification, the roentgen thology of duodenal ulcer explains all of its roentgenological pects on a sound and logical basis.

After analyzing Guttmann's[14] classification in conjunction with housands of our X-rays, we adopted it for our work. Two of its ubclassifications were discarded: "The Sclero-edematous" and "The Ulcer with Periduodenitis." The final classification, as adapted nd condensed, may be summed up briefly as follows:

1. The edematous ulcerative type which shows a more or less ormal outline, with a zone of diminished density, and a round, ense barium-filled crater in its center—the niche. The ulcerative process, being limited to the mucous and sub-mucous coats, does not produce any reflex contraction that may cause undue distortion of he bulb. This type of roentgen pathology is usually associated with arly acute ulcerations (Fig. 1).

2. The edematous type, with incipient sclerosis, discloses a more dvanced stage where the edema of the mucous membrane makes he mucous folds appear as if radiating towards the niche. In this ype, reflex contraction is increased; besides the radiating mucous olds, a spastic distortion of the bulb, with pseudo-diverticular ap- earance, may be evident. These diverticuli are frequently so small hat they may be erroneously taken as the niche itself (Fig. 2).

3. The sclerotic type of duodenal ulcer usually presents the most pronounced deformities of bulb contour. These roentgenological eatures are indicative of old, chronic scarring processes (Fig. 3). It s in this type of duodenal ulcer where, confronted by the most izarre distortion, roentgenological parlance has coined such de- criptive phrases as Maltese cross, clover leaf, and collar button eformities.

Without wishing to minimize distortion of the bulb as a true roent- enological evidence of duodenal ulcer, we have attempted to prove hat all spastic distortions, and the so-called cicatricial contractions, re secondary to the niche itself. After finding in the course of

13. P. G. Bowman, Compression technique in gastro-duodenal roentgen diagnosis. J.A.M.A., 15, 1930.

14. R. A. Guttmann, *Les sindromes douleureux de la région épigastrique. 11me. ed.* (Paris: Doin, 1934).

examination of our series that a number of duodenal bulbs, which fulfilled the classical description of normal duodenum, showed on subsequent examinations definite barium-filled craters indicative of ulcerating lesions, our faith in the roentgenological normal duodenum has faltered. In most of our cases we have based our diagnosis of duodenal ulcer on the presence of clearcut and definite niches.

Only in chronic ulcers, where the bulbar shadow is affected by scarring processes, and in bleeding ulcers, where the crater is easily perforated by rough handling, in addition to being covered with blood clots, is the niche difficult to determine. However, even in these cases, as will be shown later, a conscientious search will amply repay all technical difficulties encountered.

It was not until 1943 that our X-ray Department intensified the search for the niche. Previous to this year, and unless absolutely contraindicated, all X-rays of the duodenum had been taken in an upright position. Out of 186 positive diagnoses for duodenal ulcers, 16 percent reported niches.

During the years 1943 and 1944, when all X-rays of the duodenum were taken in a horizontal position with Bucky and compression technic, out of 230 positive cases niches were determined in 63 percent of them. We believe that a careful search was not made in a considerable number with obvious bulbar distortion.

Analysis of our series would show that the niche was disclosed in a substantial number of instances without any attempt at localizing it. As a routine matter, our department insisted on four X-rays taken after the administration of a thin mixture of barium. Occasionally, the information obtained from the analysis of this group of films proved sufficient. However, in the majority of cases, four X-rays were taken, three minutes apart, after the administration of the usual mixture of contrast media. Again, when the first group of films did not show the niche, another four plates would be taken with appropriate compression technic.

In order to visualize the mucosal pattern of the bulb, we used all kinds of devices, one of them, the cotton ball recommended by Akerlund. Another device, described by Sante[15] but originated by Chaoul,[16] was the rubber bladder encased in a canvas belt, which was used in hundreds of cases. In order to determine the amount of compression required in relation to the weight of the patient, we added, as an experiment, an aneroid manometer to Chaoul's device

15. L. R. Sante, *Manual of Roentgenological Technique, 9th ed.* (Ann Arbor, Michigan: Edwards Brothers, 1942).

16. H. Chaoul, *Diagnostique Radiologique-clinique de l'appareil digestif* (Berlin, 1928).

tried to express in terms of millimeters of mercury the amount compression required. Although unsuccessful to the present time, modified device is still the object of experimentation.

The use of compression produces a dislodgement of the barium ixture from the mucosal elevations and shows the intervening oughs and ulcerating excavations. Some authorities, among them, yman, stress the fact that slight compression gives the best results. our work we have found that, under normal conditions, there is a eat variance in the amount required. At the beginning of this udy, we were under the impression that the weight of the patient as in direct relation to the amount needed. Now we know that here are other factors, such as a pendulous abdomen or tense dominal muscles, which have to be taken into consideration. our X-rays taken with different amounts of compression will suffice determine which is the correct amount to be used in a particular ase.

SUMMARY

1. Again and again in the series of X-ray studies of the gastrointestinal tract, we have found in four consecutive X-rays, bulbs ulfilling the classical description of a normal duodenum but showing typical niche surrounded by an area of edema when slight compression was exerted (Figs. 4 and 5).

2. Irregularity of the duodenal contour, with definite border deormities, have not always appeared in consecutive X-rays; when the uodenal bulb is well filled, a perfectly normal contour appears (Fig. 6).

3. Even under the best conditions, the niche is not always deected; occasionally, definite bulging of one of the borders in the ight oblique X-ray will lead one to be more painstaking, and the iche *en face* will be finally discovered.

4. The niche *en face* is a reproduction of an ulcerating lesion either anterior or posterior wall of the bulb. It is frequently possible to duce from the right oblique X-ray whether the ulcer is anteriorly ulging in the basal border) or posteriorly (bulging in the medial rder) located.

5. Different compression from that which a normal body exerts is always essential for the detection of the niche. Slight compresn very frequently brings out a spastic deformity; increased comssion brings out the niche. On the other hand, the niche disapars under increased compression with despairing frequency.

6. Not all niches are clearly outlined. Some of them are detected

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5. Different compression from that which a normal body exerts is always essential for the detection of the niche. Slight compression very frequently brings out a spastic deformity; increased compression brings out the niche. On the other hand, the niche disappears under increased compression with despairing frequency.

6. Not all niches are clearly outlined. Some of them are detected

as small pin-point densities towards which the mucous folds radiate in stellate fashion (Fig. 7).

7. An unusual but characteristic picture of the niche *en face* is described by French observers under the name of "borroulet hemorrhoidare." The zone of edema around the niche is interrupted by many mucous folds, giving the impression that the barium-filled crater is surrounded by irregular but clear spaces (Fig 8).

CONCLUSION

A careful analysis of 4,175 X-ray studies of the gastrointestinal tract attempts to show:

1. That the niche is the only direct evidence of duodenal ulcer.
2. That distortion of the duodenal bulb may occur, and very frequently occurs, in the absence of duodenal lesions.
3. That with but few exceptions, the niche is observed whenever an ulcer is present, provided sufficient X-rays are taken and proper compression is exerted.
4. That if bulbar distortion were not of such common occurrence and apparently so easily recognized and interpreted, the niche would be given more importance in diagnosing duodenal ulcer.
5. That all barium specks, lodged between the folds of the mucous membrane, are not to be considered as evidence of the niche.
6. That though at present we are not in a definite position to confirm our repeated assertion that the niche is consistent with healed duodenal ulcer, we hold definite doubts as to the correctness of the assertion, made by others, that its presence is an indication of ulcer activity.
7. That recognition of the niche is a matter of experience and education.

CHART NO. I

4175 GASTRO INTESTINAL SERIES

	1940	1941	1942	1943	1944
[illegible]					
[illegible] G. I. SERIES	128	323	1315	1302	1017
[illegible] OF PATIENTS	128	323	1211	1043	964
	47	279	1191	935	937
[illegible]	81	44	20	97	27
[illegible]	87	207	627	613	357
[illegible] RICANS	41	116	584	430	607

LEGEND

CHART I

Distribution of gastrointestinal examinations according to year, sex, and nationality

(Apparent discrepancy between the number of patients and the number of X-rays performed may be explained by the fact that many of the positive cases were usually rechecked.)

PIE

CUADRO I

Distribución de las radiografías en cada año, de acuerdo con el sexo y la nacionalidad de los enfermos

(La discrepancia entre el número de enfermos y el de radiografías gastrointestinales, que se tomaron, se debe a que muchos casos positivos fueron radiografiados varias veces.)

CHART - NO. II

ROENTGEN PATHOLOGY IN - 4175 - GASTRO INTESTINAL SERIES.

YEAR	1940 --	1941 --	1942 --	1943 --	1944
DUODENAL ULCER	11	30	145	107	123
GASTRIC ULCER	1	0	3	4	7
GASTRIC CANCER	0	0	3	0	1
DUODENITIS	5	3	13	2	3
DIVERTICULOSIS DUODENAL	0	1	1	3	4
HYPERTROPHIC GASTRITIS	5	7	5	0	2
ESOPHAGEAL VARICES	1	0	3	0	0
GASTRIC SYPHILIS	0	0	1	0	0
DIAPHRAGMATIC HERNIA	0	0	1	1	0
PERFORATED ULCER	0	0	2	3	2

LEGEND

CHART II

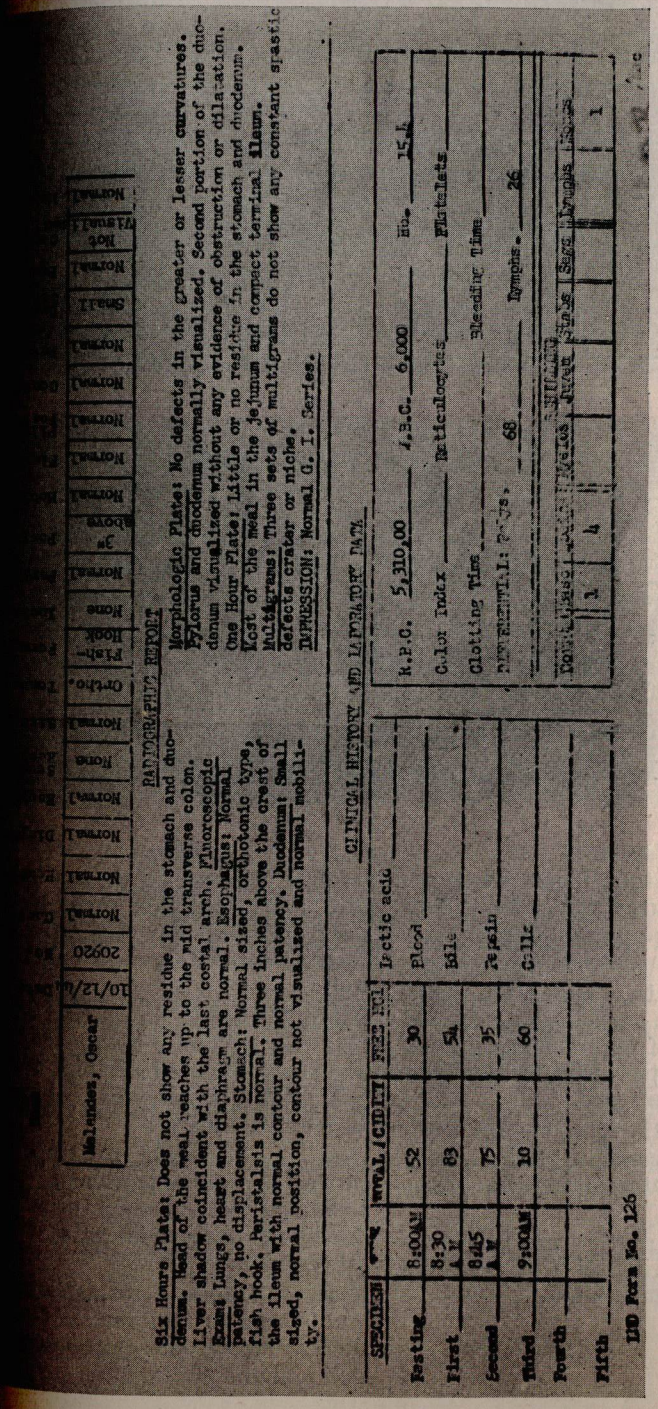
Roentgen pathology in 4,175 X-ray studies of the gastrointestinal tract. (The 4 cases of gastric cancer were admitted through the OPD Clinic. The case of gastric lues was confirmed, treated, and cured at the Marine Hospital, San Juan. The cases of hypertrophic gastritis of 1942 were not confirmed by subsequent gastroscopic examinations.)

PIE

CUADRO II

Lesiones anatomopatológicas demostradas en 4,175 estudios radiográficos del canal gastrointestinal

(Los 4 casos de cáncer del estómago fueron remitidos por el Departamento de Enfermos. El caso de lesiones sifilíticas fué debidamente comprobado, tratado y curado en el *Marine Hospital* de San Juan. Los 2 casos de gastritis hipertrófica, correspondientes al año 1943, no pudieron confirmarse en los exámenes gastroscópicos realizados después.)



LEGEND

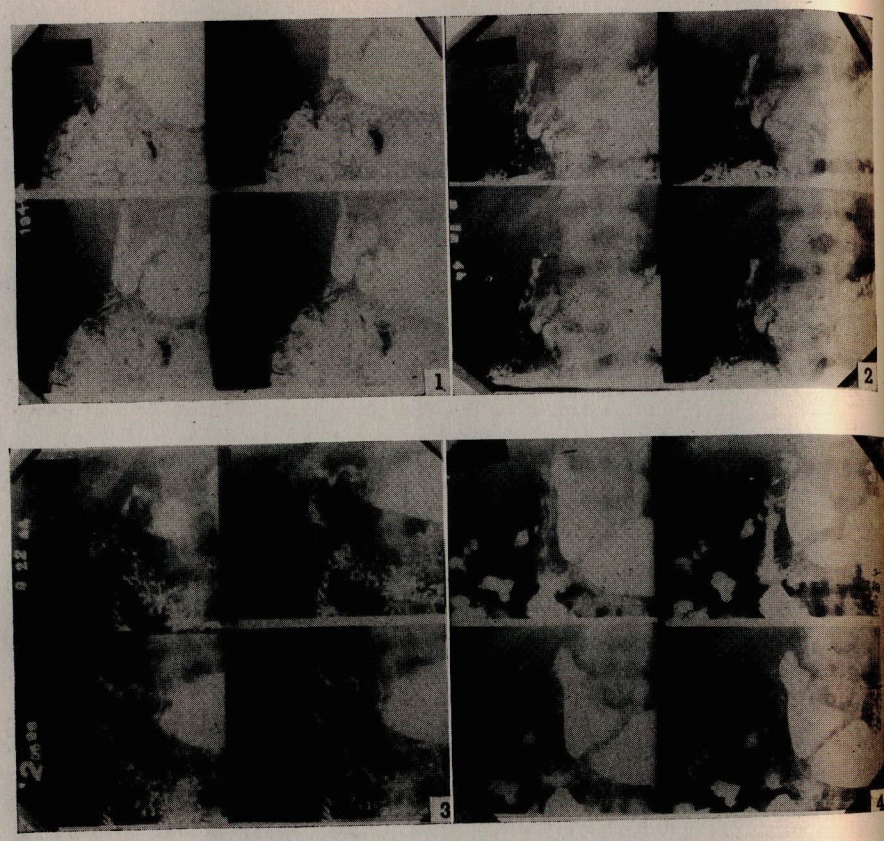
CHART III

Card prepared for the tabulation of al. information pertaining to X-ray examinations

PIE

CUADRO III

Tarjeta para hacer la tabulación de todos los datos referentes al examen radiográfico



LEGENDS

Fig. 1. Edematous ulcerative type, usually associated with early acute ulcerations; the most frequent type encountered in the series studied.

Fig. 2. Edematous type with incipient sclerosis, usually associated with history of previous gastric disturbances; type of ulceration frequently encountered.

Fig. 3. Sclerotic type, usually associated with bizarre distortions, very rarely encountered in the series studied.

Fig. 4. Apparently normal duodenum appearing in 4 consecutive X-rays; no compression.

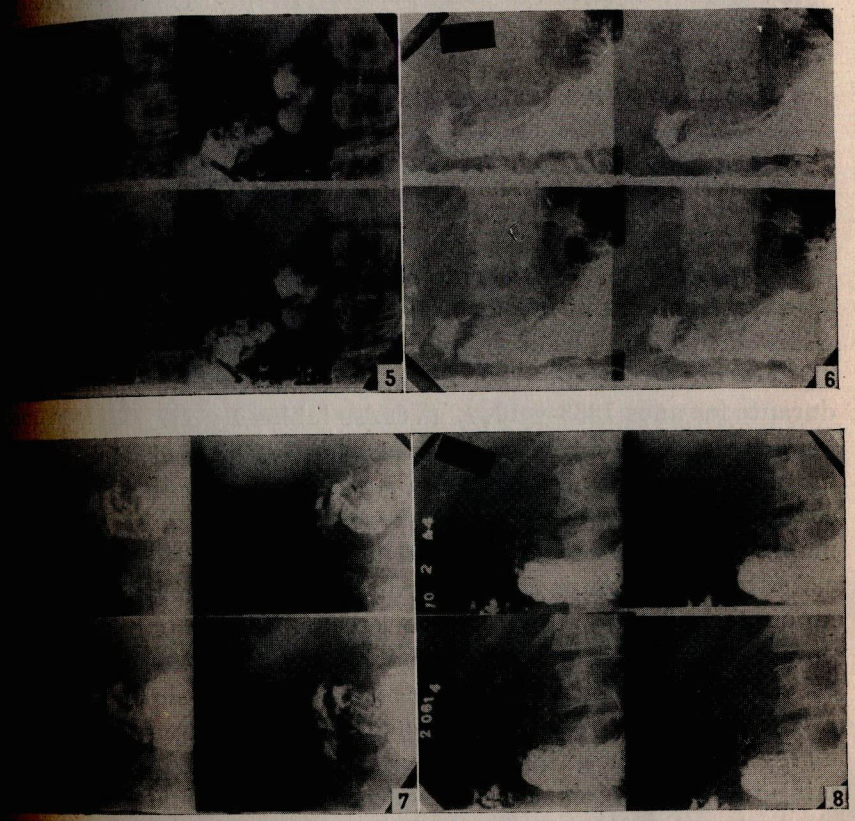
PIES

Grab. 1. Ulceración de tipo edematoso, cuya aparición suele ser temprana y aguda; es el tipo más frecuentemente observado en este estudio.

Grab. 2. Ulceración de tipo edematoso con esclerosis incipiente, en la que generalmente ha habido trastornos gástricos previos; observada frecuentemente.

Grab. 3. Ulceración de tipo esclerótico, en que generalmente se observan contorsiones pintorescas del duodeno; observada rara vez en este estudio.

Grab. 4. Duodeno de aspecto normal en cuatro radiografías tomadas sucesivamente sin ejercer compresión abdominal.



LEGENDS

5. Normal duodenum with typ- niche *en face* surrounded by of edema; slight compression ted.

6. Irregular duodenal contour; not always be evidence of ul- tive lesion.

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8. Unusual but characteristic re of niche *en face*, described by ch authors by the name of *oulet hemorrhoidare*.

PIES

Grab. 5. Duodeno normal con el "nicho" de aspecto típico visto *en face*, rodeado de un área edematosa. Radiografía tomada ejerciendo leve presión.

Grab. 6. Duodeno de contorno irregular, cuyo aspecto no siempre indica la existencia de lesión ulcerosa.

Grab. 7. El "nicho" aparece como una cabeza de alfiler, de la que irradian numerosos pliegues de la mucosa hasta adoptar una forma estrellada.

Grab. 8. Imágen radiográfica poco corriente, pero muy característica, del "nicho" *en face* denominado por los autores franceses *borroulet hemorrhoidare*.