THE STOMACH OF THE RECENTLY DECEASED*

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A vast literature exists on the subject of gastric pathology, but we are still ignorant of the true incidence and severity of "simple chronic gastritis" among the general population. Figures relating to the presence of such gastritis in resected stomachs have a value limited by the presence of peptic ulceration or neoplasm. Opportunities for gastric biopsy are few; moreover, a piece of gastric mucosa removed at biopsy is insufficiently representative of the whole mucosa. Again, a patient's symptoms are an unreliable indication of gastritis.

Gastritis is not merely an interesting academic problem. It is a popular and widely accepted opinion that chronic gastritis is a common condition, but the truth is that in clinical practice, in the majority of cases, we do not know whether it is the man or his stomach that is at fault. Meanwhile vast quantities of stomach sedative will continue to be prescribed at no mean cost to the State.

Valuable information concerning the condition of the stomach can be obtained if the organ is adequately fixed immediately after death. Early fixation is essential for accurate interpretation of the morbid-anatomical findings. Magnus (1937a, 1937b) re-stressed the necessity for this. He showed that autolysis begins usually within 30 to 45 minutes of death in the adult, though much later in the foetal stomach, and that fixation by intraperitoneal injection, as first practised by Faber 50 years ago, is inadequate, whereas direct intragastric injection of fixative soon after death gives excellent results. The technique of intragastric fixation requires the minimum of skill and apparatus, yet it is a method which has been remarkably neglected. Many have regarded the procedure as a ghoulish business. To become sentimental in this way is to impede good and useful knowledge. The manipulation of the corpse is naturally unpleasant but in no way irreverent.

Magnus examined over 30 stomachs fixed shortly after death in patients whose principal disease was not gastric. This series, to my knowledge, represents the largest recorded. My own series includes 62 unselected post-natal stomachs, the majority of which were adult, and 10 foetal stomachs. They were all formalin-fixed according to Magnus's rulings.

Technical Procedures

Fixation.—All the stomachs were fixed with 10% formol-saline. Adult stomachs were fixed within one-half to three-quarters of an hour of death. An ordinary oesophageal tube, permanently strengthened with a length of strong pliable wire, was passed over the tongue and along the posterior pharyngeal wall into the stomach. Then 1½ to 2 pints (0.85 to 1.14 litres) of fixative was quickly poured down the tube through a large glass funnel. Alternatively, fixation can be effected by passing a large-bore needle into the stomach through the seventh or eighth left intercostal space or through the epigastrium. This method, however, is uncertain in its results. Children's and infants' stomachs require an appropriately smaller amount of fixative, passed

into the stomach through either a No. 4 Jaques stomach-tube or a wide-bore needle. The stomachs of large foetuses were filled by direct intubation or by needling. Those of smaller foetuses were removed from the abdomen and immersed in fixative.

Macroscopic Examination.—At necropsy the oesophagus, stomach, and duodenum were removed as one piece. Each stomach was opened by an incision in the anterior wall midway between the curvatures. After careful examination of the mucosa the specimen was then immersed in formol-saline for at least 24 hours. Later, representative pieces of stomach wall were taken from at least five sites: (a) oesophago-gastric junction, (b) fundus, (c) body, (d) pyloric antrum, and (e) pyloro-duodenal junction. These were kept in formol-saline for a day or two, then washed, dehydrated, embedded in paraffin, and stained with haematoxylin and eosin. Special stains, such as those for mucin, Paneth's cells, argentaffine cells, collagen, and fibrin, while giving a pleasant picture, were not considered essential.

Morbid-anatomical Findings

As the result of a careful macroscopic and microscopical examination, each stomach, considered as a whole, was placed in one of five grades: Grade 1, normal; Grade 2, showing mild chronic gastritis; Grade 3, showing rather more severe chronic gastritis; Grade 4, showing severe chronic gastritis; Grade 5, showing very severe chronic gastritis. Only stomachs in Grades 4 and 5 could be considered to have "serious" gastritis. No case of pure acute gastritis was encountered, although many of the cases of chronic gastritis showed a greater or less acute inflammatory element.

Before recording the results of investigation it is necessary to consider the normal mucosal structure and also what is understood by chronic gastritis.

Normal Gastric Mucosa.—Histologists are more or less agreed upon the glandular structure of the mucosa, but there is still some confusion concerning the cellular elements of the mucosal stroma. The stroma of the healthy adult stomach contains reticulum cells, lymphocytes, plasma cells, and scanty polymorphs. No plasma cells were ever found in the foetal or early post-natal stomachs. They are fairly abundant in later life, even in the healthy mucosa. Probably they arise from the reticulum cells (Lowenhaupt, 1945; Bessis and Scebat, 1946; Fagraeus, 1948), and it is possible that they serve a useful physiological purpose.

Chronic Gastritis.—There is a current belief that the presence of more than a few plasma cells and lymphocytes in the stomach mucosa spells chronic gastritis. This is an erroneous view. In the intestine the normal mucosa contains abundant plasma cells and lymphocytes, yet many would deny the stomach this privilege. As already mentioned, they probably serve a useful physiological function. Only when there are parenchymal changes accompanied by considerable inflammatory cell infiltration is one entitled to diagnose gastritis histologically. "Intestinalization" of the gastric mucosa—i.e., the appearance of goblet cells and Paneth's cells—is characteristic of the severe grades of chronic gastritis. A mucosa very severely affected by chronic gastritis shows great devastation, with considerable degeneration, atrophy, and disappearance of glands, and frequently enormous stuffing of the stroma with chronic inflammatory cells.

No case of diffuse non-inflammatory atrophy of the gastric mucosa, corresponding to Lubarsch's diffuse atrophic pangastritis, was found. A characteristic of

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chronic gastritis is its patchy nature. Although the antropylic part of the stomach was commonly diseased there was no obvious predilection for this region. The severity of inflammatory lesions in the immediate vicinity of ulcers as contrasted with the mildness of such lesions in the mucosa a little more distant was often observed, suggesting that the inflammation was secondary to the ulcer, and not vice versa.

The severity of histological lesions tends to increase with age (see Table). By applying the χ^2 statistical test

Table Showing Number and Age of Stomachs in Each Grade (72 Cases)

Grade	Age of Stomach in Years										Total
	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91+	
1	14*	1		1	1			2			19
2	4			1	1		3	3			14
3	1		2	1	3		5	2			21
4				1		5	1	8	1	2	17
5						6		1			7

* Including 10 foetal.

(the "exact χ^2 method") it can be demonstrated that the odds are 100 to 1 that histological grading does depend on age. Eliminating foetal stomachs, the odds are about 50 to 1. But 5 out of 16 stomachs in the 71-80 years group and 2 out of 3 in the 81-90 years group were remarkably healthy.

There is definite proof that with increasing age there is a diminishing power of gastric secretion (Bloomfield and Pollard, 1933; Davies and James, 1930-1). After the age of 40 the production of HCl and pepsin by the stomach of both sexes diminishes. Above the age of 60 about 60% have histamine-fast achlorhydria. Ivy in 1942 stated that no unchallengeable evidence existed concerning the effect of senescence on the morphology of the stomach. The present series revealed no obvious cause-and-effect relationship between age *per se* and atrophy *per se*.

Aetiology of Chronic Gastritis

Many agents are said to be capable of producing gastritis:—(1) *Exogenous agents*: mechanical and chemical irritants. (2) *Endogenous agents*: (a) infections, (b) hyperchlorhydria, (c) metabolic substances—e.g., in uraemia and in burns, (d) avitaminoses—e.g., in sprue, (e) venous stasis, and (f) possibly nervous stimulation of the stomach.

Attention will be focused on the influence of infections and uraemia. Many observers, from Beaumont (1838) onwards, have bracketed infection with gastritis—e.g., gastritis was noted in association with influenza (Vimtrup, 1929) and with diphtheria (Nyfeldt and Vimtrup, 1932). Experimental gastritis has been produced by the injection of bacterial substances (Enriques and Hallion, 1893; Einar Thomsen, 1925). Many have described gastritis in association with uraemia.

An analysis of the necropsy specimens revealed the following data.

Group 1 Specimens (19 stomachs, including 10 foetal and 5 adult).—Of the five adults four had moderately severe bronchopneumonia. In addition one showed severe urinary infection, one fairly severe intestinal infection, and one marked bronchiectasis and uraemia. Arteriosclerosis of any magnitude was found in only one adult stomach—in one of the cases with moderately severe infection. The four infants whose stomachs were in this group had no infection at necropsy.

Group 2 Specimens (14 stomachs).—There was infection in 10 cases—principally pulmonary in seven, principally urinary in two, wholly peritoneal in one. Uraemia was present in

only one case. Arteriosclerosis of any magnitude was found in only two stomachs.

Group 3 Specimens (21 stomachs).—There was infection in 12 cases—principally pulmonary in seven (including two cases of tuberculosis), principally urinary in one, one case was an ulcerating carcinoma of the hepatic flexure with a small paracolic abscess, another a tuberculous spine, and two were cases of acute gastro-enteritis. There were two cases of uraemia, one of which showed infection also. Arteriosclerosis was present in only two stomachs. The cases without infection or uraemia included a case of multilobular cirrhosis of the liver, a case of Hodgkin's disease, and a case of status asthmaticus.

Group 4 Specimens (17 adult stomachs).—Infection was present in eight cases—principally pulmonary in six, principally urinary in two. Uraemia was present in five cases, accompanied by infection in four of these. Arteriosclerosis of moderate severity was present in three stomachs. Two of the cases in this group were of suspected nutritional deficiency.

Group 5 Specimen.—This patient was an adult suffering from hypertension with cerebral changes and a fractured femur. There was no mention of infection in the necropsy report, but this cannot be excluded, and was, in fact, a strong probability.

Thus, infection was established in roughly one-half of the 72 cases, or, excluding the foetal stomachs, in about 60%. Chronic infection was twice as common as acute infection, and of the chronic infections pride of place went to bronchiectasis and pyelonephritis. Infection was not present to a significant degree in all cases of severe gastritis, yet it was sometimes found to be marked in cases with mild gastritis or in association with anatomically normal stomachs. Uraemia was present in nine cases, but six of these also had extragastric infection. It was invariably accompanied by gastritis, often severe.

Ulcers and Erosions

Ten of the cases showed one or more ulcers in the stomach—i.e., 15% of the adult stomachs. Acute ulcers were present in four stomachs and chronic ulcers in seven. The average age of the patients with ulcers was 67. In no instance had ulcer been diagnosed during life. Six of the ulcerated stomachs showed severe gastritis, three showed milder gastritis, and in one carcinoma ventriculi was present.

Hart (1918-19) and Stewart (1929) found chronic peptic ulcers or scars thereof in 10% of all necropsies. Doll (quoted by Avery Jones, 1947) made a statistical survey of working men in industry and transport and found a 5-7% incidence of peptic ulcer. Avery Jones (1947) studied 615 peptic ulcer patients. Of these, two-thirds were males and 33% were over 60. He drew attention to the apparently increasing age of the ulcer population and to the considerable rise in mortality in those patients over 60 who have not had surgical assistance.

A study of the material under review suggests that the increasing incidence of ulcers in the older age groups is related more to failure of the general health of the patient than to local factors. Excluding the case of carcinoma ventriculi, seven out of the nine cases of gastric ulcer were patients with extensive extragastric infection: one patient had pneumonia with purulent pericarditis, another bronchial carcinoma, three had bronchiectasis, and two had severe urinary infection.

Erosions were found in 18 stomachs—i.e., in 30% of post-natal stomachs. In four of these there was also ulceration. These erosions showed no characteristic distribution. They appeared in any part of the mucosa. They varied in size and shape from minute round specks, just visible to the naked eye, to round, oval, or irregular excavations. In depth they varied from simple desquamations to

neo-ulcers. They were frequently multiple. They were or were not accompanied by gastritis. Often they showed evidence of recent or old haemorrhage. The simplest erosions were minute deficiencies in the superficial part of a congested but otherwise normal mucosa. The edges of these erosions had a pale blurred appearance due, presumably, to the digestive action of gastric juice.

Polymorphs were or were not present. Sometimes they formed a distinct cuff around the edges of an erosion. Other erosions were simply miniature ulcers, stuffed with polymorphs and set in a very inflamed mucosa. Most, if not all, of the erosions without polymorphs were agonal; nevertheless the underlying mechanism of production may play an important part in the pathogenesis of some, perhaps many, erosions and ulcers. One may suggest that contractions of the muscle wall of the stomach produce haemorrhages which burst through the covering epithelium. Support is lent to the importance of a vascular origin for these agonal erosions by three facts: (1) their localization to minute areas of mucosa, (2) their frequent occurrence in an otherwise normal mucosa, and (3) the almost invariable finding of whole or altered blood in them.

The gastro-intestinal mucosa is immensely rich in blood vessels, and it is probable that rupture of these vessels is a frequent pre-erosion phenomenon. It is likely, therefore, that many so-called primary peptic secondary haemorrhagic erosions are really primary haemorrhagic secondary peptic.

Summary

The examination of 72 unselected stomachs, formalin-fixed according to Magnus's rulings, is described.

The specimens were divided into five histological grades according to their health or disease.

The need for a stricter standard of histological diagnosis of chronic gastritis is emphasized.

It is shown that the severity of chronic gastritis tends to increase with age.

Uraemia was constantly associated with chronic gastritis, often of severe degree. Severe chronic infections were often, though not invariably, associated with chronic gastritis.

Ulceration of the stomach was found in 15% of adult cases; the average age of these patients was 67. The ulcers were undiagnosed during life.

Erosions were discovered in 30% of the non-foetal stomachs. Many of these were agonal.

It is suggested that a vascular origin for erosions and ulcers is commoner than has been supposed.

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DIPHTHERIA IMMUNIZATION WITH P.T.A.P. IN ADULTS

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During the last diphtheria epidemic in Bergen, in 1942-5, an extensive immunization campaign against diphtheria was carried out among school-children. This active immunization was probably largely responsible for a gradual but definite shift in the age distribution of the patients. While the frequency of diphtheria showed an appreciable decline among school-children, the disease attacked adults with an increasing frequency, both relative and absolute. Accordingly there is reason to extend the immunization to include susceptible older children and young adults (Vogelsang, 1949).

In such subjects the prophylactic most commonly used—alum-precipitated toxoid (A.P.T.)—may give unpleasant reactions after inoculation. It is therefore recommended to use instead toxoid-antitoxin floccules (T.A.F.) which, however, is a less efficient antigen and is given in three injections, each of 1 ml., at intervals of three or more weeks.

Holt (1947) has produced a purified toxoid, aluminium-phosphate precipitated (P.T.A.P.), which is said in its antigenicity, stability, and freedom from reactions to have distinct advantages over A.P.T. (Holt and Bousfield, 1949). Studies on the immunizing power of this new prophylactic have been carried out in nurses and medical students.

The subjects were first Schick-tested, and only the Schick-positive were immunized with a batch of P.T.A.P., E.3160 R, Lf 10, 10 mg. AlPO₄/ml. The doses given were two inoculations, each of 0.5 ml., intramuscularly in the left fossa supraspinata, with an interval of one month between