THE DIAGNOSTIC VALUE OF GASTRIC FRACTIONAL TEST MEALS.

BY

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THE following remarks are based on the examination of over two hundred fractional test meals undertaken during the last fifteen months. Nearly all these meals were withdrawn from patients presenting either symptoms or physical signs pointing to an abdominal lesion; other cases included persons thought to be normal and a few patients in whom the condition was definitely extra-abdominal.

The meal employed was that recommended by Ryle,¹ withdrawn by means of a Refluss tube; the material withdrawn was filtered, and (in the filtrate) estimations of total acidity and of free hydrochloric acid were made by the Töpfer method. If the presence of bile was obvious search was made for it with the aid of acetone and nitric acid; microscopic examination both of the unfiltered gastric residuum and of the meal was also carried out. In a number of cases the chloride content was estimated by the Volhard-Arnold method and hydrogen-ion concentration determined by the use of indicators. Correlation was also made, whenever possible, with clinical, radiographic, and verified findings.

Before setting out the actual findings, which are largely confirmatory of the work of others, it will perhaps be permissible to consider some points in relation to gastric secretion. Various views are held on the association between gastric secretory change and gastro-intestinal lesion, according to the supposed priority of one or the other event.² However this may be, it is certain that the amount of gastric secretion poured out in response to the stimulus of various substances introduced into the stomach is controlled to some extent by the operation of certain factors. The importance of one of these factors was emphasized by Boldyreff,³ who suggested an explanation for the fact that the acidity of fluid withdrawn from the stomach has not the same value (in terms of total titratable acidity) as that of freshly secreted fluid. In the light of recent and past investigations some of these factors which influence the time-acidity curve of gastric secretion may be summarized.

1. *Rate and Nature of Secretion.*—In the first place this must depend upon the amount of chemical or psychic stimulus brought to bear upon the gastric mucosa. By the use of uniform test meals given at the same hour the chemical stimulus may be presumed to be, roughly, of constant value; psychic effect can in some measure be avoided by careful manipulation of the Refluss tube. Apart from these two factors, the rate and amount of secretion may be assumed to be a property of the particular gastric mucosa which is being examined.

2. *Rate of Evacuation of Stomach.*—It is this factor which, though not apparent in its influence in the earlier period of gastric secretion, is so largely effective in shaping the curve later on when the pylorus has opened sufficiently. Its effect on total acidity may be different from that on free hydrochloric acid content, as pointed out by Bennett and Venables.⁴ Taken alone, its most potent effect would appear to be exhibited in the time-acidity curve of the duodenal ulcer with hurry; its influence may also be inferred from the inspection of curves in cases of pyloric obstruction where this factor is obviously in abeyance.

3. *Rate of Neutralization or Dilution brought about by Regurgitation from the Intestines.*—It is evident that this factor must operate in association with the preceding one, since both depend upon the opening of the pylorus, except in cases of gastro-enterostomy or gastro-colic fistula. The existence of this factor may be demonstrated by the finding of trypsin or bile in the stomach;⁵ rate of dilution and rate of neutralization may be determined by total and inorganic chloride fractional estimations, as recently shown by Bolton and Goodhart⁶ amongst others. It would appear possible that the excessive operation of this factor might produce an achylia, complete neutralization being perhaps evoked by an original gastric hypersecretion.

Leaving out of account other possible but unknown factors such as the part played by the vascular system, some sort of general relationship may be formulated between the above and the acid concentration (total acidity) of the fluid withdrawn from the stomach. If C represent any point on the total acidity curve, S the rate of gastric secretion, E the rate of

evacuation, and R the rate of intestinal regurgitation, then it would appear that C varies directly as S and indirectly as E and R, or

$$C \text{ varies as } \frac{S}{E \text{ and } R}.$$

This relation cannot be considered as being in any way exact, because, although the associated factors E and R would appear to operate almost at once,⁷ it is certain that they reach higher values at a later period.

In the following six types, into which most of the curves obtained were divisible, an attempt has been made to interpret the shape and significance by reference to the above expression. Alterations in the factors S, E, and R are commonly found in association with gastro-intestinal or other lesions; it is legitimate, therefore, to assume that a curve expressing the shifting values of C, which itself varies with these factors, may show some specific relation with these same lesions. At the same time it must be admitted that such specific curves are by no means invariably obtained.

Curve Type 1 (Fig. 1).

This is the normal curve obtained by most observers—from Schüle in 1895⁸ to the present day. Here the factors S, E, and R would appear to have either fixed or balanced values, as it is obvious that the value of C would remain the same if there were similar increases in the values of S and R; this is, of course, the basis of the principle of automatic regulation advanced by Boldyreff.

FIG. 1.—Curve Type 1.
Case 139.

FIG. 2.—Curve Type 2.
Case 32.

In each of the figures the total acidity is represented by a continuous line, and the free HCl by a broken line.

Curve Type 2 (Fig. 2).

Known sometimes as the curve of larval hyperacidity (Hawk), this type has been associated with gastric ulceration; in my own series 83 per cent. of cases proved at operation to be of gastric ulcer gave this picture. It would appear that an originally high value of S is reduced later by a rise in the value of R, as shown by the entry of bile. In one case of gastric ulcer a curve of Type 6 was obtained, indicating perhaps an excess of the neutralizing factor; unfortunately no chloride estimations were made in this case.

Curve Type 2 can be taken therefore to indicate hypersecretion without much disturbance of normal gastric evacuation, a condition often present in ulcers of the lesser curvature.

Curve Type 3 (Fig. 3).

Here it is obvious that the value of E is so great as to lead to a rapid disappearance of recoverable gastric contents. High resting acidity is also a feature of this type of curve, as observed by Ryle⁹ and others; in my own series this picture with high resting acidity has been obtained in cases of duodenal ulcer, and, without high resting acidity but with a late rise in the inorganic chloride curve, after gastro-enterostomy. Out of seven cases of duodenal ulcer, a curve of this type was obtained in five instances, and of Type 5 in the remaining two.

FIG. 3.—Curve Type 3.
Case 30.

FIG. 4.—Curve Type 4.
Case 119.

Curve Type 4 (Fig. 4).

This is the type of curve usually present in cases of maintained pyloric obstruction, where it is obvious that the factors E and R can have little or no influence on the value of C; associated with this may be a raised or normal secretion value. In cases of malignant obstruction the high free hydrochloric acid curve may be absent, being replaced by an organic acid curve. This type seems to be of considerable diagnostic value and is almost invariably obtained in severe grades of pyloric stenosis; all such cases in my own series gave this picture.

Case.	Clinical.	Radiographic.	Frac. Test Meal.	Verified.	Case.	Clinical.	Radiographic.	Frac. Test Meal.	Verified.
6	Gastric ulcer	? Duodenal ulcer	Type 2	Pyloric ulcer.	72	Gastric ulcer	Gastric ulcer	Type 2	Large ulcer, lesser curvature.
13	" "	? Duodenal ulcer	Type 5	Appendicitis.	77	?	Delay in large intestines	Type 5	Appendicitis.
17	" "	Delay in emptying, otherwise normal	Type 2	Ulcer on lesser curvature.	78	?	Nil abnormal	Type 2	Nil at operation.
18	Recurrent gastric ulcer	Gastro-enterostomy working	Type 6	Perigastric adhesions only.	80	Gastric ulcer	Nil abnormal	Type 2	Ulcer near cardia.
20	Gastric ulcer	Two indentations on greater curvature	Type 2	Ulcer on lesser curvature.	82	?	Hour-glass stomach or ulcer	Type 1	Perigastric adhesions.
22	?	Nil abnormal	Type 5	Nil found at operation.	83	?	? Pyloric ulcer	Type 2	Distended duodenum (? Wilkie).
27	?	Nil abnormal	Type 4	Pyloric cicatrix.	85	?	Nil found; ? duodenal obstruction	Type 2 and 5	Pyloric ulcer; appendicitis.
28	Gastric ulcer	? Pyloric stenosis	Type 4	Pyloric stenosis.	92	Gall stones	? Colitis	Type 5	Enteroptosis.
30	Duodenal ulcer	Small hypertonic stomach	Type 3	Duodenal ulcer.	103	Gastric ulcer	Hour-glass stomach	Type 1	Cardiac ulcer.
32	Gastric ulcer	Hour-glass stomach	Type 2	Two ulcers on lesser curvature.	106	" "	No record	Type 5	Pyloric ulcer.
35	" "	? Gastric ulcer	Type 6	Minute ulcer near pylorus.	115	Pyloric spasm	Pyloric stenosis	Type 1	Nil found.
37	" "	? Duodenal ulcer	Type 2	Carcinoma on lesser curvature.	116	Gastric ulcer	? Pyloric ulcer	Type 3	Duodenal ulcer.
38	" "	Pyloric ulcer	Type 4 and 5	Pyloric ulcer.	117	" "	Nil abnormal	Type 1	Mobile kidneys.
45	" "	Nil abnormal	Type 1	Nil abnormal.	118	" "	Hypertonic stomach ? duodenal irritation	Type 6	Mobile kidneys.
46	?	? Duodenal ulcer	Type 1	Nil abnormal.	119	Carcinoma of stomach	Fundal new growth	Type 4	Simple pyloric stenosis.
56	Carcinoma of stomach	Nil abnormal in stomach	Type 6	Gall stones.	123	Gall stones	? Pyloric stenosis	Type 1	Gall stones.
57	Gastric ulcer	Ulcer middle of greater curvature	Type 1	Small ulcer of fundus.	141	? Nil	? Duodenal ulcer	Type 5	Duodenal ulcer.
58	" "	Duodenal ulcer	Type 3	Duodenal ulcer.	142	?	? Pyloric stenosis; ? duodenal ulcer	Type 4	Simple pyloric stenosis.
64	" "	? Pyloric ulcer	Type 1	Gastric ulcer.	151	?	? Duodenal ulcer	Type 2	Ulcer near pylorus.
67	?	? Prepyloric ulceration	Type 6	Mobile kidneys.	152	Pyloric ulcer	? Duodenal irritation	Type 4	Pyloric stenosis.

Curve Type 5 (Fig. 5).

This is the "climbing" curve or curve of tardive hyperacidity (Hawk), due presumably to deficient relaxation or spasm of the pylorus of a non-continuous type; this picture has also been seen in what can only be called idiopathic hyperchlorhydria, since no spasm or cause for spasm could be recognized. A great majority of these curves were, in my own series, associated with either small pyloric ulcers (leading presumably to spasm), or with subpyloric conditions, such as appendicitis, where perhaps pyloric spasm was a reflex event similar to that observed in the experimental intestinal injuries of Cannon and Murphy. Removal of the subpyloric condition, which was postulated as a cause of the "reflex hyperchlorhydria" expressed by this type of curve, has, in my own series, been followed by an alteration approximating to Type 1.

Curves of this type were obtained in six cases which came to operation, and which exhibited lesions varying from a small pyloric ulcer to an inflamed appendix.

FIG. 5.—Curve Type 5.
Case 81. FIG. 6.—Curve Type 6.
Case 108.

Curve Type 6 (Fig. 6).

The so-called achylic curve, which may mean deficient secretion or early and complete neutralization, has personally been obtained in a variety of conditions which appear unrelated. These included normal cases and cases of gastric ulcer, gastric carcinoma, gall stones, movable kidneys, gastroptosis after gastro-enterostomy, and, in six instances, of exophthalmic goitre. There does not, therefore, seem to be any great diagnostic value in this type of curve, since it can be obtained in so great a number of conditions; on the other hand, it can serve as an indicator of the efficiency of the stoma when a gastro-enterostomy has been made.

From a general consideration of these curves valuable help in diagnosis would seem to be given, particularly by Types 2, 4, and 5. A comparison of this and other evidence with the actual finding as discovered by operation will, however, best illustrate this statement. The accompanying table shows that the fractional test meal method is worthy of comparison with the recognized method of opaque meals and x rays. Forty cases have been taken at random; in each the clinical, radiographic, fractional test meal, and verified findings have been set out.

In concluding this note, I would wish to express my indebtedness to my colleagues at the David Lewis Northern Hospital for the provision of some of the clinical material.

Conclusions.

1. The acidity curves plotted from fractional test meals are of some value in obtaining knowledge of the factors which modify the acidity.

2. Alterations in these factors bear some sort of relation to gastro-intestinal lesions; hence the acidity curves may throw some light on these lesions.

3. These curves seem divisible into at least six types of varying diagnostic value.

4. By comparison with other methods the fractional test meal is at least admissible as an aid to diagnosis.

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TREATMENT OF HUMAN HOOKWORM INFECTION
WITH CARBON TETRACHLORIDE.

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In the *Journal of the American Medical Association* of November 19th, 1921, Dr. Maurice C. Hall, of the United States Bureau of Animal Industry, published a paper on the use of carbon tetrachloride for the removal of worms in animals. He stated that the results were satisfactory, and that almost all worms were removed by one dose. He recommended that 0.3 c.cm. should be given for every kilogram of weight of the animal. He tested the drug on monkeys, and gave two to five times this amount, and reported that no untoward symptoms ensued. Dr. Hall himself took in the morning 3 c.cm. of carbon tetrachloride, and afterwards did his usual day's work and was not inconvenienced in any way. He suggested that the drug would be valuable for the treatment of hookworm disease in man.

Several drugs are used at present for the treatment of this infestation, but all of them have disadvantages. Thymol and beta-naphthol, except in large doses, are ineffective, and are