Original Articles.

A NEW TEST MEAL.

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THE test meal has become an absolute requisite for the examination of stomach contents. One of the chief reasons for this is the difficulty of obtaining gastric juice from the fasting stomach; in fact, when any considerable amount of gastric juice can be obtained from the fasting stomach, it is generally considered to be in a pathological condition. Three meals have been chiefly employed for this purpose. One was proposed by Ewald, another by Riegel, and still another by Klemperer. That of Ewald, or as it is sometimes known, Ewald and Boas, consists of one to two rolls, in Berlin parlance called a *Schuppe*, which weigh from 35 to 70 grammes, and two glasses of water. For this we have an excellent substitute in the ordinary round cracker, of which two weigh on an average 30 to 31 grammes, or in the soda wafers, four of which weigh on an average 35 grammes. With this meal, the contents should be withdrawn one hour after eating.

The meal of Riegel consists of soup, a beefsteak and a roll. It is to be withdrawn three to four hours after eating. Klemperer's meal consists of half a litre of milk and two rolls, to be withdrawn two hours after eating. There are serious objections to all of these: (1) The indefiniteness of the amount of the food elements employed, nitrogen, fat and carbohydrate, and (2) that on account of the lack of fine division, the tube introduced is frequently clogged, which necessitates its removal, its cleansing and reintroduction.

The meal employed in these experiments consisted of 2 grammes of dried egg albumin compressed into half-gramme tablets. These are to be taken with two glasses of water, and the contents withdrawn one hour after taking. For the preparation of these tablets my thanks are due to the Metcalf Co., who furnished them at my suggestion. This amount of albumin is equivalent to that found in the crackers, but in a different and more soluble form. Seven per cent. of dried bread, and consequently of crackers, consists of nitrogenous substances. This calculated for 30 grammes of crackers would give 2.1 grammes of albumin, the equivalent of that found in the four tablets. The latter, however, are very much better digested than the vegetable albumin, and hence there is much less residue. True, the nature of the starch digestion cannot be determined from such a meal, but can be as easily determined from the amount of free hydrochloric present, for the organic acids, if present, are seldom in large enough amounts to disturb amylaceous digestion, and combined hydrochloric acid has no inhibitory action upon this. With this meal the contents never clog the tube, there is always a definite amount taken, and the contents filter much more readily than when vegetable albumin is used. It also avoids a large mass of starch granules, always present when making microscopic examinations. These tablets when once compressed can be preserved indefinitely, are always on hand, and can be given to the patient without his departure from the office or clinic. Furthermore, lactic acid when found is of vastly more diagnostic importance than after the Ewald meal.

When amylaceous matter has been given it is difficult to limit the disappearance of lactic acid to an hour, but in this case the acid must come from the remnants of the last meal, and hence point to a lack of motility. For cases on which to demonstrate this meal, my thanks are due to Dr. R. F. Chase, who kindly placed his dispensary service at my disposal. The meal was given to 18 patients on whom 57 examinations were made at different times, and to 16 patients only once, so that a total of 73 examinations were made. These patients had all of them symptoms which were attributed to the stomach, such as distress, heartburn, eructations of gas, nausea and vomiting. In this new departure, of course, it is advisable to compare the results of the examination with those from an Ewald meal. The following cases were selected for this purpose.

COMPARISON WITH EWALD MEAL.

D. W. was given on two consecutive days, first, the albumin meal, then the Ewald meal. With the albumin meal the amount withdrawn was 50 c. c. with no free HCl as tested with dimethyl-amido-azo-benzol, and combined HCl amounting to .3 per mille. There was no lactic acid. With the Ewald meal the amount withdrawn was 82 c. c. There was free HCl to the extent of .8 per mille, and combined HCl of .6 per mille, or a total of 1.4 per mille. Lactic acid was present.

E. B. Two examinations with the albumin meal, at an interval of five days, showed respectively amounts withdrawn of 132 and 43 c. c. There was free HCl in both amounting to 1.6 per mille, and no lactic acid; while 3 examinations with the Ewald meal, immediately following the former at intervals of seven days, showed amounts of 134, 156 and 94 c. c. The free HCl was respectively 1.5, 1.3 and 1.53 per mille, while in the last examination the combined HCl was .25 per mille, making a total of free and combined HCl of 1.78 per mille. There was a trace of lactic acid present in every examination.

A. A. With albumin meal, total amount withdrawn, 95 c. c.; free HCl, 1.49 per mille; total HCl, 2.22 per mille; no lactic acid present. With Ewald meal seven days afterwards, total amount, 122 c. c.; free HCl, 1.95 per mille; total HCl, 2.73 per mille; a trace of lactic acid, and starch in the form of erythro-dextrin.

H. L. With albumin meal, total amount, 145 c. c.; free HCl, 1.35 per mille; total HCl, 1.82 per mille; no lactic acid. Five days afterward with Ewald meal, total amount, 52 c. c.; free HCl, .8 per mille; total HCl, 1.49 per mille; lactic acid present; erythro-dextrin.

S. With albumin meal, total amount, 75 c. c.; free HCl, 1.67 per mille; total HCl, 2.4 per mille. Two weeks afterwards with Ewald meal, total amount, 88 c. c.; free HCl, .9 per mille; total HCl, 1.2 per mille; lactic acid present and erythro-dextrin.

L. With albumin meal, total amount, 15 c. c.; no free, and no combined HCl, but a total acidity of 10 parts per hundred; lactic acid present. With Ewald meal two weeks after, total amount, 40 c. c.; no free HCl; combined and total HCl, .4 per mille; lactic acid; achroodextrin.

O'N. With albumin meal, total amount, 60 c. c.; free HCl, 1.82 per mille; total HCl, 2.62 per

mille; lactic acid present. With Ewald meal five days after, the total amount, 80 c. c.; free HCl, 1.82 per mille; total HCl, 2.59 per mille; lactic acid present.

In order to present these results in a more convenient form for comparison, a short table has been prepared comprising the results already stated, and needing no further explanation:

TABLE OF COMPARISON.

Name.	Meal.	Amount Withdrawn.	Free HCl per mille.	Total HCl per mille.	Lactic Acid.
D. W.	Albumin.	50 c. c.	None.	.3	No.
	Ewald.	82 c. c.	.8	1.4	Yes.
E. B.	Albumin.	132 c. c.	1.6	1.6	No.
		43 c. c.			
		134 c. c.			
	Ewald.	156 c. c.	1.5	1.78	Yes.
		94 c. c.	1.3		
		91 c. c.	1.5		
A. A.	Albumin.	95 c. c.	1.49	2.22	No.
	Ewald.	122 c. c.	1.95	2.73	Yes.
H. L.	Albumin.	145 c. c.	1.31	1.82	No.
	Ewald.	52 c. c.	.8	1.49	Yes.
S.	Albumin.	75 c. c.	1.67	2.4	No.
	Ewald.	88 c. c.	.9	1.3	Yes.
L.	Albumin.	15 c. c.	None.	None.	Yes.
	Ewald.	40 c. c.	None.	.4	Yes.
O'N.	Albumin.	60 c. c.	1.82	2.62	Yes.
	Ewald.	80 c. c.	1.82	2.59	Yes.

The first impression that one would derive from such a comparison would be that more HCl would be found with animal albumin than with vegetable albumin. By referring to our results, however, we find that HCl in the Ewald meal exceeds the HCl in the albumin meal four times out of seven. Another thing which attracts our attention is that the lactic acid is present in the Ewald meal and not in the albumin meal in all cases but two, where it is present in both. Another thing quite noticeable, that with the Ewald meal the amount withdrawn is generally larger than with the albumin meal. It is very probable that this is due to the greater need of a vegetable albumin for fluid to accomplish its digestion, or chemically speaking, its hydration. There is unquestionably an osmosis or interchange of fluids between the blood on the one side and the contents of the stomach on the other.

CHEMICAL NATURE OF GASTRIC CONTENTS WITH REFERENCE TO HCl, AMOUNT, ETC.

The course of some of the cases affords some interesting observations. On A. J., who complained of gaseous, non-acid eructations, vomiting, etc., eight examinations were made, covering a period of two months. Starting with an entire absence of HCl, the amount gradually increased until at the close the HCl had reached 1.8 parts per mille. On account of the early lack of the HCl, a quantitative test for rennin was made, which showed that milk could be coagulated with a dilution of 1-80 of the stomach contents, a result not far from normal. Lactic acid was invariably present. The increase of amount withdrawn from 12 c. c. to 72 c. c. may have been due to the increased

muscular tone of the stomach walls. This is further substantiated by the fact that, at first, suction was necessary to remove the contents, but at last voluntary compression on the part of the patient was sufficient.

The case of M. M., followed for one month with five examinations, showed a persistently low amount of HCl varying from entire absence to a total of .8 per mille. Here also the rennin was found to be active in dilutions of 1-180 and repeated microscopic examinations showed no cancer cells, when examined by the methods proposed by Hemmeter.

The case of Mary M., followed for seven weeks with seven examinations, showed the most marked variations in the HCl, due probably to nervous origin. They were respectively 1.3, .6, 0, 1.35, .8, 1.38 and 1.5 per mille, under the same conditions of meal, time of removal, etc. Lactic acid was also present when HCl was below .8 per mille, which must have come from the previous meal, since only albumin was used. On one occasion, bile was present in the stomach contents, which indicated only reflex vomiting from the introduction of the tube, since it was not persistent.

In the case of J. G. three examinations made in one week showed a total HCl of respectively .04, 1.3 and 1.2 per mille, and total amounts withdrawn of 102 c. c., 42 c. c. and 97 c. c.

The case of T. L. came nearest to being one of continuous secretion of gastric juice. At periods of from fourteen to sixteen hours after food had been taken, there were removed from the stomach on five occasions amounts respectively of 55 c. c., 80 c. c., 30 c. c., 87 c. c. and 19 c. c. This was of an almost watery consistency, perfectly clear, containing no food particles whatever, whose total HCl was .9, .7, .8 and .4 per mille. After an albumin test meal, 260 c. c. of stomach contents were withdrawn which had a total HCl of .8 per mille.

DISCUSSION OF DIFFERENT FEATURES.

Upon comparing the amounts withdrawn, we find that there was

Less than 20 c. c.	9 times.
20 to 40 c. c.	24 "
40 " 60 "	16 "
60 " 80 "	11 "
80 " 100 "	7 "
Over 100 "	8 "

Included among these results are two Ewald meals. The rest, however, were from albumin meals. The amounts withdrawn at intervals of an hour seem to depend largely upon the muscular tone of the stomach. It is very difficult, however, to set a limit beyond which we may say that hypotony or dilatation exists, and under which the stomach is normal. From the other conditions involved, it seems that with the albumin meal we may say that there is lack of muscular tone when 100 c. c. or more can be withdrawn. This is especially true if it is necessary to use suction, or if in introducing water for purposes of lavage it cannot be withdrawn readily, or a whirling motion in the funnel is noticed upon its introduction. The presence of free HCl was always determined by dimethyl-amido-azo-benzol, and was found present in 60 examinations and absent in 13. Lactic acid was determined by the modified Uffelmann test in the following way: One drop of ferric chloride was placed in a test tube, the test tube filled with water, this then divided into equal parts in two test tubes, each filled

up with water, and a drop or two of the filtered stomach contents added to one, the other serving as a control. As demonstrated by this test, lactic acid was found 40 times, 9 times with no free HCl, and twice the entire absence of free HCl was accompanied also by the absence of lactic acid. This is contrary to the teachings of Boas, who claims that lactic acid is absent when HCl is present to any appreciable amount, one hour after the meal. As our supposition is that the lactic acid must come from the previous meal, and be indicative of atony, then it should be associated with a large amount of contents. This cannot be demonstrated, however, since it is found when the amount of contents withdrawn varied all the way from 10 to 102 c.c. Lactic acid was also found when the free HCl rose to 1.8 per mille. As combined HCl has no inhibitory action upon the formation of volatile acids by their respective bacilli, no account was taken of it. A more detailed account of this association is given as follows: Lactic acid was found twice with a free HCl, of 1.8 per mille, once with 1.7, twice with 1.6, once with 1.5, twice with 1.3, twice with 1 per mille, and so on down. Its presence followed certain cases, as that of A. J., throughout the course of examination. The latter never lost the lactic acid in spite of the fact that his HCl steadily increased from nothing to 1.8 per mille.

In 40 cases only were both free and combined HCl or total HCl determined, and that by the method of Töpfer. In the rest, only the free HCl and the total acidity were determined. Of the entire number of examinations in which the albumin meal was given (73), there were, as already stated,

No free HCl in	13
Less than .5 per mille in	7
Between .5 and 1 per mille in	12
" 1 " 1.5 "	19
" 1.5 " 2 "	12
" 2 " 2.5 "	6
" 2.5 " 3 "	0
Over 3 per mille in	4

In the 40 cases where free and combined or total HCl were determined there was entire absence of both in only 3 cases. The total free and combined HCl was

Less than .5 total HCl per mille	9
Between .5 and 1 per mille	0
" 1 " 1.5 "	7
" 1.5 " 2 "	4
" 2 " 2.5 "	10
" 2.5 " 3 "	4
Over 3 per mille	6

As compared with the results of H. F. Hewes,¹ where the limits of normal total HCl were from 1.1 to 2.6, and the average from 1.2 to 2.5 per mille, 21 fall within these limits, 9 below and 10 above. Bile was present twice, and with the bile there was once associated pancreatic juice, which was demonstrated by the fact that the stomach contents in alkaline medium could both digest albumin and convert starch. Bile is not so rare in stomach contents, but is much more apt to be present in the first withdrawal in a patient, from the retching accompanying the introduction of the tube. After the patient has become accustomed to this introduction, the presence of bile is much less frequent. If it persists a long period, Boas² considers it a sign of the constriction of the duodenum, while Bouveret³ prefers to regard it not only as evidence of a constriction of the duodenum, but also of

a patent pylorus. These conditions can only be differentiated by blowing up the stomach with air. Under normal conditions no air can pass through the pylorus on account of its spasmodic closure, and hence the intestines cannot become distended.

Rennin was always looked for where the total HCl was very much diminished, and no free HCl was present. The quantitative method of Boas was employed, which is as follows: One c.c. of stomach contents was diluted with water to 10 c.c. Five of this was taken in a test tube, and was again diluted to 10 c.c., and 5 c.c. more taken. The process continued until we had four test tubes with 5 c.c. of diluted contents in dilutions of 1-10, 1-20, 1-40 and 1-80. To each of these were added 5 c.c. of cooled boiled milk and a few minims of calcium chloride solution. We now have dilutions of 1-20, 1-40, 1-80 and 1-160. A control test is always prepared to guard against the possibility of spontaneous coagulation, consisting of 5 c.c. of milk, 5 c.c. of water, and the same amount of calcium chloride. These tubes are all placed in a brood oven, at a temperature of 30°, for from twenty to thirty minutes, and then note made of the coagulation.

Coagulation normally should take place in dilutions of from 1-80 to 1-160. The importance of this test cannot be over-estimated in cases of suspected cancer, being of vastly more importance than diminution of HCl or the presence of lactic acid. In all of our cases, coagulation was found in dilutions of 1-80 or over. In every case the contents were also examined with the microscope, and while several times fragments of mucous membrane of the stomach were found, nothing was seen approximating the peculiar arrangement of these cells in cancer of the stomach. These results were also verified by Dr. Timothy Leary, our pathologist, who kindly offered to assist in these examinations. Yeast fungi were always present; no degree of acidity nor use of albumin stayed their growth in any way. No sarcinae were found, fairly good evidence that in all cases no marked dilatation nor narrowing of the pylorus was present.

Among the interesting points brought out was the unreliability of the presence of lactic acid as a diagnostic symptom. It was present in the majority of cases where the Ewald meal was used, and also in very many cases where the albumin meal was used, and as a diagnostic symptom seems to have lost its significance. It is also quite evident that impaired motility is the most important condition in the so-called nervous dyspepsias, arising probably from the lack of enervation dependent upon shock or worry. It may be present with either impaired or superabundant secretion of HCl. The former condition is probably the more distressing from the formation of organic acids and gases. The importance of this motility can also be demonstrated by laboratory experiments in artificial digestion, where shaking the contents of flask or container accelerates in such a marked degree the process of digestion. It is of interest also that the increased flow of gastric juice is always accompanied by a relative increase in the amount of HCl, or it may be that lack of motility and diminished HCl are associated, and the small quantity withdrawn is due to our inability to remove the total contents of the stomach. Finally, dried egg albumin in the form of tablets seems to fulfil all the conditions that attach to a successful test meal.

¹ Boston Medical and Surgical Journal, vol. cxlii, No. 20.
² Diagnostik u. Therap. der Magenkrankheiten, 1 Th., S. 276, 1897.
³ Traité des maladies de l'estomac, 1893, p. 32.