Methods and techniques

New methods of studying intestinal transit times

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Previous methods for measuring transit times through the alimentary tract have included the use of coloured markers, radiological studies following injection of contrast material, and observations of the position of the telemeter capsule used to record intraluminal pressures during passage through the alimentary tract (Bárány and Jacobson, 1964; Connell and Rowlands, 1960; Farrar and Bernstein, 1958). The first of these methods only gives the total transit time, the second involves the use of a material of greater bulk and density than the normal intestinal content and also repeated exposure to x-rays. The last method does not give accurate localization since its principal purpose is to record pressure changes.

Measurements of intraluminal pressures either by opened tubes or balloons (Code, Hightower, and Mortlock, 1952) or by the telemeter capsule can be used as indices of intestinal motility but their interpretation is difficult and they are not necessarily related to the rate of passage of intestinal contents (Connell, 1961; Edwards, 1965).

This is a preliminary report of another method for measuring intestinal transit time.

METHOD

The 'pill' consists of an araldite capsule about 1 cm. in diameter, in the centre of which is sealed a quantity of ^{131}I giving an activity of up to 10 microcuries. Also embedded in the plastic are some small lead pellets which render the capsule readily visible on an abdominal radiograph. The size of the pill makes it easily swallowed by the patient, and the araldite shields the source so that in effect it is a pure gamma emitter. The amount of radiation is such that complete decay in the same position in the intestine would not cause damage to the adjacent mucosa.

After the patient has had a light breakfast the pill is swallowed and its position in the abdomen is located by using a portable sodium iodide scintillation counter, the position of the pill being determined to an accuracy of approximately 1 cm. by suitable screening of the sodium iodide crystal with a lead collimator head. The apparatus is light enough to be taken to the bedside. The position of the pill is plotted by reference to a grid on a transparent plastic table placed over the abdomen, which at the same time supports the weight of the counting head while it is being used. Readings are made at intervals of 10 minutes and plotted on graph paper to give a visual record of the progress of the pill through the intestinal tract.

While the pill is in the stomach it is moved (or tumbled) by the gastric contractions, making it more difficult to localize accurately, it is assumed that the pill has left the stomach it is usually in the left lower quadrant of the abdomen when its position can be determined more exactly.

In a somewhat similar fashion the quite sudden change to a steady upwards movement at a slower rate in the right iliac fossa gives a reliable indication that the pill has entered the caecum. Confirmation can be obtained by a straight radiograph of the abdomen, when the lead pellets in the pill can easily be seen in the faecal shadowing and gas contrast of the caecum. Thus the time at which the pill leaves the stomach and the time at which it enters the caecum can be determined with an accuracy which is only dependant on the frequency with which readings are made, and, from these observations, the gastric emptying time and small intestinal transit time can be measured. Though passage of the pill through the colon is slow and search for the pill in the stool tedious, colon transit time can be determined similarly.

ADVANTAGES OF THIS METHOD

SIMPLICITY This is a bedside method involving simple apparatus all of which can be carried by hand. The patient needs no preparation and can eat and drink, move, and go to the lavatory while the investigation is in progress. The pill is easily swallowed.

ACCURACY Localization is exact and the only limitation to the accuracy of the depiction of the progress of the pill through the intestine is the frequency of the readings and the patience of the observer making them. There are definite subdivisions of the total transit time determinable, such as cannot be obtained by any method using markers, etc.

SAFETY There is no physical danger to the patient and the amount of radiation is such that there could be no radioactive damage. The pill can be handled by the observer and patient without precautions. Although radiographs have been taken they are only necessary for confirmatory purposes and increasing familiarity with the method decreases the need for them.

COST The pill and the apparatus are cheap and easily available. The counting apparatus is a commercial model and the pills are made by the hospital physics department, as was the plastic plotting grid.

RESULTS

We have performed 25 determinations on 24 patients. Our interest has been mainly in patients with Crohn's disease or ulcerative colitis, together with a number of 'controls' with no known gastrointestinal disorder. The results are shown on Tables I and II. Two patients were studied whose results do not appear in the tables; one had had an ileostomy for necrotizing colitis and one a vagotomy and pyloroplasty.

TABLE I

RESULTS			
	No. of Patients	Gastric Transit Time	Small Intestine Transit Time
Control	10	36 min. to over 8 hr. (mean 3 hr. 12 min.)	1½ hr. to over 16 hr. (mean 4 hr. 38 min.)
Crohn's disease	6	40 min. to 13 hr. (mean 3 hr. 43 min.)	2½ hr. to over 16 hr. (mean 6 hr. 37 min.)
Ulcerative colitis	8	2 hr. to over 10 hr. (mean 6 hr. 13 min.)	3½ hr. to over 24 hr. (mean 10 hr. 35 min.)

TABLE II

GASTRIC TRANSIT TIMES

Percentage of Patients with Gastric Transit Times of Four Hours

Control	Crohn's Disease	Ulcerative Colitis
20	16.5	75

COMMENT

As can be seen from Table II, emptying of the stomach in ulcerative colitis may be delayed. Although some patients were investigated in the active phase of their illness by no means all were toxic and in the main they were longstanding cases. In addition small intestine transit time is slow, but since in only five of eight of this group was it possible to complete the investigation due to the prolonged delay in the stomach of three, further studies of small intestinal transit are needed for confirmation. Should this distinction between the two disorders be substantiated by further study, the alimentary transit time might provide a clinical means of differentiating between Crohn's disease and ulcerative colitis.

SUMMARY

A simple, safe, inexpensive method of determining intestinal transit time (both as a whole and in components) is described. Some preliminary results of an unexpected nature are reported.

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An improved technique of perfusion of the stomach for the study of gastric secretion in the rat

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One of the methods widely used at the present time for the study of gastric secretion in the rat is that described by Ghosh and Schild (1958) or its modification by Lai (1964). It is based on the perfusion of the stomach of anaesthetized rats with saline and the measurement of the acidity of the perfusate. It is a useful method for continuous recording of the acid secreted by the stomach under various conditions during an acute experiment. It has the advantage of being technically easy, requiring relatively simple apparatus, and the interference with the physiological processes is minimal. However, it has the disadvantage that the gastric washings may be incomplete and consequently there are fluctuations in the acid content of the perfusate. The fluctuations are apparent in the basal acid tracing and during the response to various gastric stimuli. These changes may be considerable, with a coefficient of variation usually over 20%, and occur quite suddenly without obvious cause thus rendering the interpretation of the results difficult. This is especially important when assaying very small doses of gastric stimulants, where the changes in the acid output are of the order of 10 to 20%. Similar difficulties are encountered when studying inhibitory factors in gastric secretion where the changes are usually around 50%.

With our preparation we have tried to eliminate the two factors responsible for these fluctuations in the level of acidity, namely, the inadequate perfusion of the stomach by the inlet catheter and the irregular evacuation due to the large size of the gastric rumen.

TECHNIQUE

The anaesthetized rat, fed on dextrose and water ad libitum for 48 hours before the experiment, is placed on the operating table, and the stomach is exposed by a vertical mid-line incision. The duodenum is identified and its first part is brought gently into the wound. A small transverse incision is made in the duodenum a few millimetres distal to the pylorus and through it a small polythene catheter is passed into the stomach. The catheter is fixed by a silk ligature tied around the pylorus close to the wall so as to avoid injury to the small blood vessels. The rumen is then identified and through a small incision made in the dome, the tip of the malleable tube of a Mackintosh's cocaine spray is introduced into the stomach. This is tied in position by a silk ligature placed near the junction of the rumen with the body of the stomach so as to exclude as much of the rumen as possible (Fig. 1). Both the inlet and the outlet tubes are brought out through counter incisions in the left and right flanks of the