

required to evoke a sensory stimulus. These effects are even more pronounced in the Maunsell-Weir type of abdomino-anal operation in which sphincteric tonus may be lowered permanently.

In the true pull-through operations, based on a Bacon-Babcock procedure, the whole rectal ampullary mechanism is removed. The papillary mechanism may or may not be entirely removed, and if the final mucocutaneous anastomosis is within the sphincteric mechanism, there is a chance, at least, of partial continence. The involuntary internal sphincter ani should be left *in situ* whether the mucosa be removed or not as it may remain relatively tonic and unrelaxing when deprived of its sensory relaxing area, the lower rectal ampulla. If the anal papillary area or at least some of the anal canal skin remains within the sphincteric canal, this may act as a peripheral sensory area allowing the voluntary external sphincter ani to respond and just maintain continence. It is obviously somewhat chancy as there is little time latitude and a rapid response is essential. Fluid faeces, mucus or flatus may easily slip out, with resultant soiling, before the voluntary sphincter has responded. It seems probable therefore that Marden Black's modification of the pull-through operation is likely to be more successful than a truly extra-sphincteric anastomosis which relies entirely on sphincteric tonus and a conditioned defaecatory habit as the method of maintaining continence.

The difficulty which remains is the selection of cases in whom a good functional result is probable when a pull-through procedure is the only operation by which continuity of the bowel may be restored. A perineal colostomy is an abomination. Some may say that an adequate washout given daily will, by sphincteric tonus alone, give an adequate functional result. The outcome is nevertheless haphazard and a method of evaluating the sphincteric control dependent upon the peripheral anal canal mechanism is needed before operations of the pull-through type can be wholeheartedly advised. One thing seems certain: the anal canal mechanism cannot be relied upon in the elderly in whom one would particularly like to avoid a colostomy.

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Intraluminal Pressures in the Pelvic Colon

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THE majority of previous studies on the motility of the large bowel in adults have been concerned with the measurement of wall tension, using relatively large recording devices.

This present paper reports the intraluminal pressure recorded from the pelvic colon using tiny recording points. Thus we are recording colonic motility from localized lengths without the production of any artificial distension.

Method.—Recordings have been made using a metal capsule optical manometer system, described by Rowlands and his associates (1953). The recording device is a tiny balloon (10 × 7 mm.) using a very narrow-bore tube such that the total volume of the recording system is only slightly in excess of 1 c.c. Open-ended tubes were abandoned at an early stage in this work as they block, causing distortion of the record, even when a powerful bleeder is used. These tiny balloons record true intraluminal pressure and we have demonstrated that where a tiny balloon and an open-ended tube record from the same segment of bowel, the record is identical.

The patient is sigmoidoscoped without previous preparation and the recording tube passed into the bowel through the sigmoidoscope. As standard procedure, recording tips have been placed at 25, 20, and 15 cm. from the anus. Position of the tube may be checked using an image intensifier.

RESULTS

Normal Patterns

Fig. 1 is an example of a record from a person with normal bowel habit. By far the most common waves seen represent a slow pressure change varying in amplitude in different patients and in the same patient at different times. They are usually of less than 20 cm. water pressure but may occasionally reach pressures of 70 cm. in normal subjects. There is, however, a remarkable constancy in the frequency of these contractions. During the active phases they seldom vary beyond the range of 2–2.7 per minute. In view of their almost universal occurrence in the sigmoid traces I have called them principal waves. These correspond to Type II waves of the standard notation.

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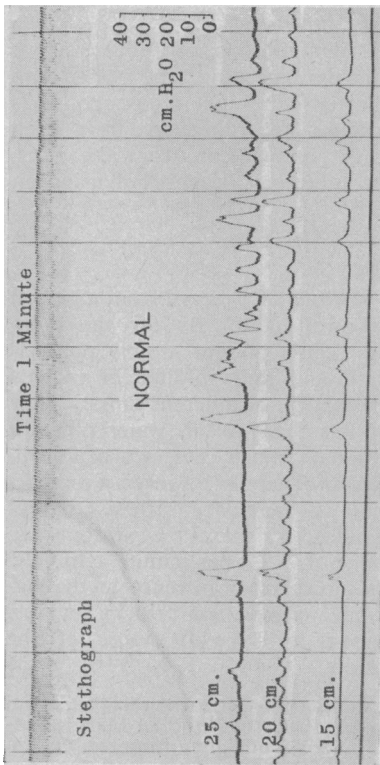


FIG. 1.—Normal motility patterns—simultaneous recordings with balloons at 25, 20, 15 cm. from anus. Upper trace—stethograph.

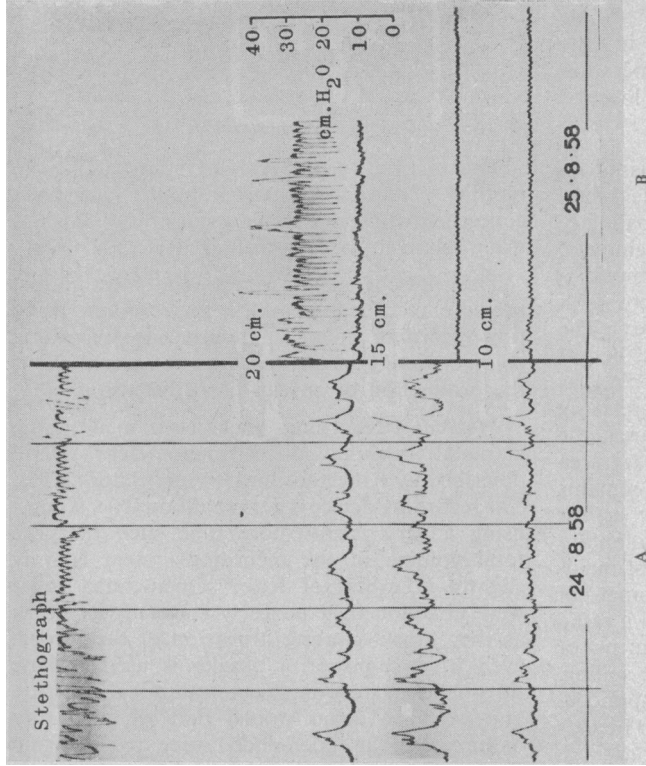


FIG. 3.—Effect of diarrhoea on motility. A, Constipated; B, Acute diarrhoea.

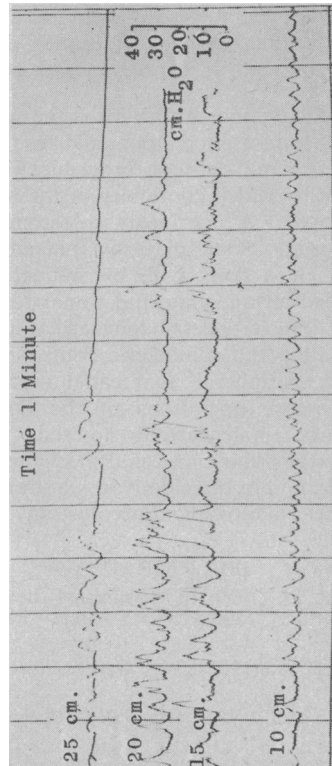


FIG. 2.—Lowest channel (10 cm. from anus) showing rapid frequency activity.

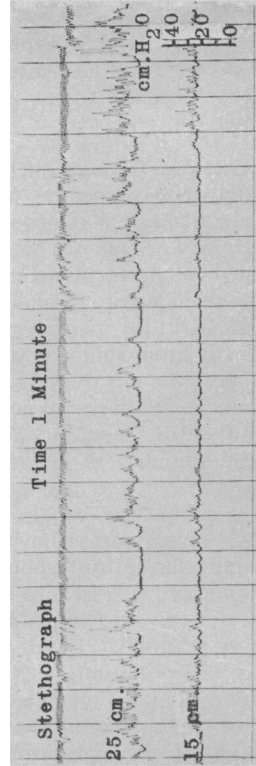


FIG. 4.—Upper trace stethograph. Middle trace: motility at 25 cm. from anus. Lower trace: motility at 15 cm. from anus. Rapid frequency pattern.

Although solitary waves may occur, the principal waves tend to be grouped into phases of activity alternating with phases of relative inactivity. The duration and proportion of these active and inactive periods vary widely and would appear to be related amongst other things to eating, sleeping and the degree of fullness of the sigmoid.

There is little correlation or co-ordination of records obtained simultaneously from adjacent segments. This is the usual finding in these records. Co-ordinated waves which probably represent forward progressive contraction are rarely seen. Waves representing retrograde peristalsis are less rare. The major activity of the pelvic colon is a slow independent segmental contraction lasting about one half-minute which does not appear to have any progressive function. It is likely that these contractions delay the forward movement of fæces.

Traces taken from below 15 cm. frequently show a different pattern from those from high levels (Fig. 2). The record from 10 cm. (lowest tracing) contrasts with those from 15 to 20 cm. Rapid frequency (3–10/min.) low amplitude contractions may occur up to 100% of the time over considerable periods. This type of activity is occasionally seen at points farther from the anus in persons with normal bowel habit but rarely for more than 5% of the time of analysis. It corresponds to Type I of the standard notation.

A detailed analysis of these irregular records is of course very difficult and the interpretation necessarily subjective. Furthermore, no method of analysis and systematization has been devised which takes account of all the possible variations in activity. These traces have been analysed in half-hour periods with respect to

- (1) Total time of activity expressed as a percentage of the time of analysis.
- (2) Amplitude of principal contractions—the number of contractions in each sub-group being expressed as a percentage of the total number of principal contractions.
- (3) The frequency of the principal waves during the active phases.
- (4) The percentage of the time of analysis in which high frequency (Type I) waves are seen.

The results of this analysis are set out in Table I.

TABLE I.—ANALYSIS OF COLONIC MOTILITY IN PATIENTS WITH NORMAL BOWEL HABIT

Distance from anus	20–25 cm.	15–20 cm.	10–15 cm.
No. of analyses min.	28	24	24
Duration of activity %	71	67	67
Frequency min. . .	2.1	2.2	2.3
Amplitude			
>20 cm. % . . .	10	6.3	3.5
>10 <20 cm. % . . .	12.5	16.8	7.3
>5 <10 cm. % . . .	18	21.5	20.1
Type I % . . .	1	1	10

Patterns from Patients with Disordered Bowel Habit

Applying this analysis to records from patients with disorders of bowel function, certain fairly clear-cut groups can be recognized. The material presented is taken from records from over 100 patients, the great majority of whom were suffering from functional disorders of the large bowel. By this I refer to that group of patients with troublesome colonic-type symptoms with persistent or intermittent irregularity of defæcation but in whom there is no radiological, bacteriological or endoscopic abnormality. The clinical diagnosis may be irritable bowel, spastic colon, colonic neurosis or simply constipation. Rather more than half the patients of this group have motility patterns which are in all respects normal. However, others fall into fairly well-defined and atypical groups.

A. *Patients with active diarrhæa at time of recording.*—Contrary to expectation, records taken during an active diarrhæal phase are nearly always flat. In 14 patients with the irritable bowel complex and 8 with non-specific ulcerative colitis where the record was obtained during an active diarrhæal phase, 18 were flat. Fig. 3 contrasts the motility pattern in the same patient on two successive days. The trace on the left-hand side was obtained at a time when he had not defæcated for three days. The trace on the right was obtained the following day when he had severe diarrhæa. The difference is marked. The same phenomenon has been seen in non-specific ulcerative colitis where, in relapse, the motility pattern is flat, with a return of recordable activity when the disease is in remission. Similar flat traces are seen following administration of large doses of certain antispasmodics including atropine. It would seem that in active diarrhæal states the colon does not act as a pump but as a rigid drain along which fæces passively trickle to reach the sensory receptors for the defæcation reflex. This explains a number of the clinical features such as relief by lying down, early morning onset, and the disappointing response to antispasmodics.

B. *Patients without active diarrhæa at time of recording.*—(a) *Rapid frequency group.* Approximately 20% of the patients with irritable bowel disorders show a motility pattern in which rapid frequency waves predominate (Fig. 4). The majority of the patients with this motility pattern are constipated or else have periods of constipation alternating with periods of explosive diarrhæa. A similar record may be obtained after subcutaneous injections of small doses of atropine. This pattern has also been noted in patients with low lesions of the spinal cord

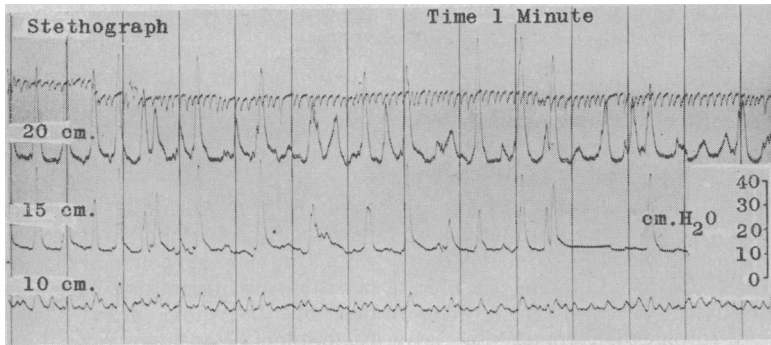


FIG. 5.—High amplitude pattern. Recording points at 20, 15 and 10 cm.

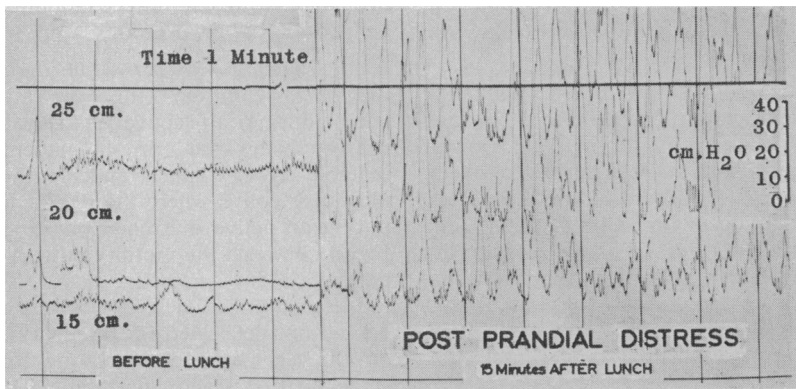


FIG. 6.—Hypermotility after a meal.

including one patient with a complete cordectomy from T.9 downwards.

(b) *High amplitude group*.—A further group shows excessive high amplitude contractions (Fig. 5). Waves of pressure of over 20 cm. of water may account for as much as 70% of the total waves in this group. This pattern is similar to that seen in the majority of subjects following injection of Prostigmin.

(c) *Post-prandial hyperactivity*.—In a number of subjects in whom the most severe symptoms occur following a meal the motility record has shown marked colonic hyperactivity in response to eating. The following example is typical.

The patient was a surgeon of 44 who had for some years suffered severe abdominal distress after meals, not relieved by any of the standard remedies. This discomfort persisted for some time and could only be relieved by lying down until flatus was passed. Intensive investigation had produced some equivocal evidence as to the presence of a duodenal ulcer and laparotomy and possible partial gastrectomy were being strongly pressed. Bowel motility studies

showed the extraordinary response to a meal demonstrated in Fig. 6. The patient's symptoms were controlled with small doses of Senokot.

Where a patient has had a repeat examination under similar clinical conditions the record obtained has been in all respects similar to the original.

Using this simple method of recording unstimulated bowel motility, some new features of sigmoid motility in health and disease have been noted. Variations from the typical pattern have been observed in conditions of abnormal bowel habit. It may not be too much to hope that the application of such methods may be of further value in the study of the physiology of the large bowel and in elucidating mechanisms of some ill-defined abdominal complaints, many of which are at present dismissed as functional.

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