The motility of the pelvic colon

Part II Paradoxical motility in diarrhoea and constipation

ALASTAIR M. CONNELL

From the M.R.C. Gastroenterology Research Unit, Central Middlesex Hospital, London

EDITORIAL SYNOPSIS The intraluminal pressure changes of the pelvic colon in subjects suffering from active diarrhoea have been compared with those in normal subjects and in subjects with intractable constipation.

Patients studied during a phase of active diarrhoea have significantly fewer intraluminal pressure changes than normal subjects. Young patients with chronic severe constipation have a tendency to more active motility than normal subjects, but other constipated persons tend to have hypomotile records. The relationship of these pressure changes to the aetiology of diarrhoea and constipation is discussed.

Diarrhoea and constipation are the symptoms most commonly associated with colonic dysfunction. Constipation is classified as either spastic or atonic but the decision into which group to place an individual case is usually quite arbitrary. Spastic constipation is thought to result from overactivity of the colonic musculature and atonic constipation from underactivity of the muscle. On the other hand, although diarrhoea is said to result from colonic hypermotility, the colonic movements which underlie the symptom are inadequately understood and poorly studied. Radiological studies of the colon have been largely concerned with anatomical alteration and few functional studies have been reported. Another approach is to measure colonic intraluminal pressures and this method has been adopted in the present study. The motility of patients with active diarrhoea and severe constipation has been studied to observe any changes in the intraluminal pressures in the distal colon associated with these symptoms.

METHODS

Intraluminal pressures have been measured using miniature balloons (7 mm. $\times$ 10 mm.) recording on a metal capsule optical manometer (Rowlands, Honour, Edwards, and Corbett, 1953). Full details of the methods of obtaining and analysing the records have been published elsewhere (Connell, 1961a). Since this publication, however, a second observer has been introduced to analyse records. This has revealed that not only is there an error of analysis between different occasions of analysis of the same record by the same observer but there are also differences between observers. The disagreement was confined

to the measurement of the duration of activity and resulted from differences of opinion about whether very low amplitude waves represented genuine colonic activity or not. In order to eliminate this error any changes in the records representing pressures of less than 3 cm. of water have been excluded from the analysis. Because of this change in procedure there are some minor, unimportant differences in the analysis of the normal results presented in this paper compared with those published previously (Connell, 1961a). All the records presented in this study have been analysed by an identical method and so are strictly comparable with one another. The term 'activity', used in this paper in relation to a motility record, refers to intraluminal pressure changes only and not to any other aspect of motility.

SUBJECTS

Records have been obtained from 86 subjects. Thirty-three complained of persistent and severe constipation, and were studied when the symptom was troublesome. Nineteen patients were studied when active diarrhoea was present and 32 were either normal subjects or persons with inactive duodenal ulceration. The latter have been discussed fully elsewhere (Connell, 1961a).

It is not possible to define constipation more precisely than to say that it exists when defaecation occurs less frequently or with more difficulty than is usual for the person concerned. In this series all the patients were sufficiently troubled by the symptom, which they considered abnormal, to seek attention and not only so, but they had been referred to hospital by another practitioner because of the particular severity or intractability of the complaint. The majority defaecated once a week or less. No case of radiological megacolon nor any person

known to have aganglionosis of the colon was included. Of the patients suffering from diarrhoea, 14 had no radiological, biochemical, or bacteriological abnormality; three had ulcerative colitis; one diarrhoea after an otherwise successful ileo-transverse colostomy for Crohn's disease; and one had taken a large dose of a laxative (Senakot) on the night before the study. All these patients had at least three watery bowel actions between rising and the time of the study which was always earlier than 2 p.m. At least four patients had an urgent call to stool before the end of the study.

RESULTS

In all three groups the predominant feature of the records is a slow wave lasting approximately half a minute (Fig. 1). Such waves are the principal waves of the colon. They vary widely in amplitude and probably represent independent segmental contractions which tend to be grouped into periods of activity alternating in an irregular manner with periods of relative or complete inactivity. They correspond to type II of the classification of Templeton and Lawson (1931). Faster waves also occur and are more prominent in the constipated group than in either of the other two groups. Large broad-based waves which correspond to type IV of Spriggs, Code, Bergen, Curtiss, and Hightower (1951) are occasionally seen and have been recognized in all three groups of records and in this series were not confined to the patients with diarrhoea.

SIGMOID COLON IN CONSTIPATED SUBJECTS The sigmoid colon is active for a greater proportion of

TABLE I
DURATION OF ACTIVITY, MEAN AMPLITUDE,
AND PRODUCT AT 20 TO 25 CM. FROM THE ANUS IN
SUBJECTS WITH DIARRHOEA, CONSTIPATION, AND
NORMAL BOWEL HABIT

	No. of Subjects	% Duration of Activity	Mean Amplitude	Product % Duration of Activity $\times$ Mean Amplitude
Diarrhoea	19	42.2 $\pm$ 26.2	10.2 $\pm$ 3.4	480 $\pm$ 355
Constipation	33	51.6 $\pm$ 26.3	10.9 $\pm$ 8.3	650 $\pm$ 608
Normal	32	47.8 $\pm$ 20.8	15.8 $\pm$ 9.2	776 $\pm$ 523

the time in constipated than in normal subjects but the total activity (duration of activity $\times$ mean amplitude) is less than in normal subjects (Table I).

There is a difference in the motility of the sigmoid colon of young and older persons who are constipated and a division has been made between those who are 40 years of age or less and those over 40. In general young persons with constipation have normal or hyperactive records whereas older persons have hypoactive records (Table II). One further important difference is that in the constipated subjects a greater proportion of the activity occurs as bursts of fast waves. If waves of a frequency of 5/min. or more (Fig. 2) only are considered, a much greater proportion of activity is occupied by these waves in the constipated subjects than in normal subjects. In records from the sigmoid of the 33 constipated subjects a mean of 15.4% of the time of analysis is occupied by fast waves as compared with only 1.8% in the normal group. Twelve of the 33 constipated

FIG. 1. Normal colonic motility. In this record and in others in this paper the top trace is a respiratory record and the lower ones simultaneous recordings of colonic motility from the sigmoid, rectosigmoid, and upper rectum respectively. The vertical lines represent one-minute intervals.

TABLE II

DURATION OF ACTIVITY, MEAN AMPLITUDE,
AND THE PRODUCT AT 15 TO 20 CM. FROM THE
ANUS IN SUBJECTS WITH DIARRHOEA, CONSTIPATION,
AND NORMAL BOWEL HABIT

	No. of Subjects	% Duration of Activity	Mean Amplitude	Product % Duration of Activity $\times$ Mean Amplitude
Diarrhoea	13	43.8 $\pm$ 30.2	8.0 $\pm$ 3.7	409 $\pm$ 438
Constipation	27	51.5 $\pm$ 30.9	9.8 $\pm$ 6.2	625 $\pm$ 611
Normal	26	40.5 $\pm$ 23.1	13.5 $\pm$ 8.6	602 $\pm$ 561

subjects had more than 10% of the analysis occupied by fast waves compared with only one of the 32 normal subjects.

UPPER RECTUM IN CONSTIPATED SUBJECTS In constipated patients the duration of activity, the mean amplitude, and the total activity (product of duration of activity $\times$ mean amplitude) is less than in normal subjects or even in persons with diarrhoea. Furthermore, whereas in the last groups the duration of activity tends to increase from sigmoid to rectum, in the constipated group the activity tends to decrease. This effect is produced by a number of constipated patients who have a normal or hyperactive sigmoid colon but a hypoactive or inactive rectum (Tables I, III, and IV).

SEGMENTAL INACTIVITY IN CONSTIPATED SUBJECTS Figure 3 illustrates a record from a constipated young woman in which there is a sharply localized

inactive segment with hyperactive segments immediately proximal and distal to it. This is a feature of only two records, one a child of 10 and the other a young woman of 32. Similar segmental inactivity has been seen in patients with megacolon (Connell, 1961b).

SIGMOID COLON IN DIARRHOEAL SUBJECTS Subjects with diarrhoea have a shorter duration of inactivity, a lower mean amplitude, and less total activity than either the normal group or the group with constipation. The total activity of the diarrhoea group is significantly less than the normal group ($p < 1 : 20$) (Table I). Large broad-based waves were not seen more commonly than in normal patients.

UPPER RECTUM IN DIARRHOEAL SUBJECTS There is a tendency for the duration of activity to increase at positions nearer to the anus (Tables I, III, IV) although the mean amplitude remains the same.

TABLE III

DURATION OF ACTIVITY, MEAN AMPLITUDE,
AND THE PRODUCT AT 10 TO 15 CM. FROM THE
ANUS IN SUBJECTS WITH DIARRHOEA, CONSTIPATION,
AND NORMAL BOWEL HABIT

	No. of Subjects	% Duration of Activity	Mean Amplitude	Product % Duration of Activity $\times$ Mean Amplitude
Diarrhoea	18	45.4 $\pm$ 21.8	9.7 $\pm$ 5.5	404 $\pm$ 353
Constipation	24	41.8 $\pm$ 30.0	6.8 $\pm$ 3.1	343 $\pm$ 338
Normal	25	53.1 $\pm$ 26	9.5 $\pm$ 5.8	527 $\pm$ 353

FIG. 2. Motility of the pelvic colon showing fast waves ($> 5/\text{min.}$) from the sigmoid and rectum respectively of a young constipated subject.

FIG. 3. Motility of the pelvic colon of a young constipated woman showing inactivity at the rectosigmoid with hyperactivity in the sigmoid and rectum. The recording points were 5 cm. apart.

FIG. 4. Motility of the pelvic colon in a patient with urgent diarrhoea showing hypomotility at all positions of recording. The stethograph is not functioning within the record.

This is in contrast to the normal subjects in whom the mean amplitude decreases from the sigmoid to the rectum.

COMPARISON OF DIARRHOEA AND CONSTIPATION The most unexpected feature of these records is that hypoactivity may be found in association with frequent bowel actions with loose stools. Figure 4 is a record from a patient who not only had frequent bowel actions but defaecated immediately before the study and in whom the study had to be terminated

prematurely because of a further urgent call to stool. A further example is provided by the case of a boy aged 18 with ulcerative colitis. The record on the left hand side of Fig. 5 was obtained at a time when he had an active proctitis and was having eight to 10 watery bowel actions a day, passing blood on each occasion. One week later, after treatment with Prednisone, he had a granular proctitis and was having three bowel actions a day with formed stools. The record on the right hand side of Fig. 5 shows the more normal motility record obtained that time.

TABLE IV

COMPARISON OF MOTILITY OF CONSTIPATED PATIENTS OVER 40 YEARS OF AGE AND OF 40 YEARS OF AGE OR LESS

Age Range (yr.)	No. of Subjects	% Duration of Activity	Mean Amplitude	Product % Duration of Activity $\times$ Mean Amplitude	% Fast Waves
At 20 to 25					
Over 40	15	42.5 $\pm$ 24.3	9.1 $\pm$ 7.3	475 $\pm$ 373	13.5 $\pm$ 18.3
40 or less	18	59.3 $\pm$ 25.1	12.3 $\pm$ 9.3	813 $\pm$ 693	16.9 $\pm$ 28.2
At 10 to 15					
Over 40	15	40.0 $\pm$ 37.0	6.6 $\pm$ 2.8	327 $\pm$ 260	
40 or less	18	43.2 $\pm$ 23.0	7.0 $\pm$ 3.5	362 $\pm$ 400

FIG. 5. Sections of two records from the pelvic colon of an 18-year-old boy with ulcerative colitis. Left, during a phase of severe active colitis showing hypomotility. Right, after treatment with symptomatic and sigmoidoscopic improvement showing return to a more normal motility pattern.

The contrast between the effect of diarrhoea and constipation on the motility record is well illustrated by Figure 6. This illustration shows samples of two records obtained on consecutive days from a patient, not otherwise included in this study, who had a functional bowel disorder with alternate diarrhoea and constipation. The hypermotile record on the left hand side of the illustration was obtained on a day when the patient had not had a bowel action for four days. The following day, however, he had five watery urgent bowel actions and the right hand trace is typical of the record obtained on that occasion.

However, the correlation between the frequency of bowel action and the intraluminal pressure records is not close. The frequency of bowel action depends not only on the colonic contractions but also on the volume and nature of the stool, the threshold for defaecation, social and personal factors, any of which may mask an association with colonic motility.

DISCUSSION

The most striking result of the study is that patients

with diarrhoea have less colonic activity than either normal subjects or severely constipated persons. Both Spriggs *et al.* (1951) and Kern, Almy, Abbot, and Bogdonoff (1951) had previously noted a reduction in colonic motility in ulcerative colitis and Kern *et al.* showed an inverse relationship between the frequency of bowel action and the total activity of the records. Chaudhary and Truelove (1961) in a study of colonic motility in ulcerative colitis also showed that patients with mild symptoms had less total activity than either patients with ulcerative colitis who were free of symptoms or normal subjects. They found, however, that the mean total activity of patients with severe colitis was greater than normal. The apparent discrepancy between this finding and those of previous workers is resolved by inspection of the individual results given in Chaudhary and Truelove's paper which show that the mean increased activity is entirely due to the effect of one exceptionally high result which is twice that of any other figures in the whole study, either normal or abnormal. If this exceptional result is excluded the mean for the other patients with severe ulcerative colitis is less than that of the normal group or of

FIG. 6. The motility of the pelvic colon in a man with a functional bowel disorder. Left, constipated with hypermotility. Right, active diarrhoea and hypomotility.

patients with ulcerative colitis in remission. In the same study patients with non-specific diarrhoea with symptoms had less activity than those without symptoms. Thus there is general agreement in the published work that there is a reduction of total motility (although not a striking one) in patients with diarrhoea if the record is obtained at a time when they have symptoms.

As was previously reported (Connell, 1961), the duration of activity of the sigmoid in constipated subjects is greater than normal and this finding is confirmed by the present study where the selection is more rigorous. If, however, the patients with constipation are separated according to age marked differences occur. Young persons usually have hyperactive records and older persons hypoactive records. This difference may represent a natural progression of the disorder which results in the symptom of constipation from an initial phase of spasm and hypermotility to a phase of atony and hypomotility. Another possibility is that the later

hypomotility is secondary to the excessive use of laxatives in the early stages of the disorder. In this respect it is of interest that the most inactive records were obtained from patients who had habitually taken large doses of laxative. One patient whose record showed no pressure changes at all had for many years used $\frac{1}{2}$ lb. of senna leaves per day.

The apparent paradox that diarrhoea can be associated with hypomotility on the one hand and constipation with hypermotility on the other, is simplified by a consideration of the mechanics of intraluminal pressure recording. In order to achieve a rise of intraluminal pressure there must be both a contraction of the wall of the viscus together with a resistance to the escape of the contents of the segment in which the recording device is placed. If the contents of the active segment are free to escape the force generated by the contraction will be utilized in movement and will not result in any marked rise in pressure. If the contents of the contracting segment are not free to escape the force generated by

the contraction will cause a rise in pressure. Conversely, therefore, intraluminal pressures reflect not only contraction of the wall of the viscus but also increased resistance to the escape of content which must be associated with delay in transit. On the other hand where the barium enema presents a 'drain pipe' appearance, as in active ulcerative colitis, there is unlikely to be resistance to the flow of faeces and considerable local contraction of the wall of the viscus may occur without effecting any significant alteration in the total volume of the lumen of the colon or in the intraluminal pressure.

In this study large waves were seen in all groups of patients studied. These waves, described as type IV, were considered by Code, Hightower, and Morlock (1952) to be associated specifically with diarrhoeal states and it has been suggested that they represent powerful peristaltic movements resulting in diarrhoea. While it is likely that when they occur they propel the faeces distally it is probable that a much more important factor in the production of diarrhoea is the loss of the normal segmenting contractions which delay the distal transport of stool. In this event the faeces passively trickle along the bowel to reach the sensory area for the defaecation reflex in the recto-sigmoid largely under the influence of gravity. This hypothesis also explains the well-known beneficial effect of recumbency on the symptom of diarrhoea and assists in explaining the disappointing effect of antispasmodics (Connell and Kellock, 1959). While this defect in motor

function of the colon is important, in diarrhoeal states, if the stool is loose or watery, there must also be a defect (possibly the primary one) in water absorption which suggests an abnormality of the function of the proximal colon or even small intestine.

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