Comparison of rectosigmoid myoelectrical activity in the irritable colon syndrome during relapses and remissions

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SUMMARY   Recent studies have suggested that a high incidence of 0·05 Hz (3 c/m) slow wave electrical activity is present within the rectosigmoid of patients with the irritable colon syndrome during symptomatic phases. However, it is known that this is a chronic relapsing disorder and in this study we have compared myoelectrical recordings, using an on-line frequency analyser, during periods of severe symptoms and asymptomatic phases. Treatment with either bran (in the form of bran tablets) or an antispasmodic resulted in 12 of the 20 patients becoming free from symptoms after one to three months. In those patients who were initially constipated a statistically significant increase in mean stool weight and a decrease in mean transit time occurred, but this was not associated with any alteration in either percentage motility or electrical activity. In patients with predominant diarrhoea no statistically significant difference occurred in either transit time or stool weight after treatment nor did the abnormal myoelectrical activity return towards normal with symptomatic improvement. These results suggest that a fixed basic myoelectrical abnormality exists which is unrelated to symptoms. This may help to explain the chronic relapsing nature of the irritable colon syndrome.

The diagnosis of the irritable colon syndrome is usually made on the clinical history and the exclusion of other possible pathology. The typical symptoms are disturbances of bowel habit, either constipation of diarrhoea, and bouts of abdominal pain, although painless diarrhoea is well recognised (Chaudhary and Truelove, 1961). The majority of patients are under the age of 40 years (Waller and Misiewicz, 1969) and women predominate (Goulston, 1972).

It is apparent from large bowel pressure studies that the colon in these patients shows abnormal motor patterns and responds abnormally to several physiological and pharmacological stimuli—for example, food (Connell *et al.*, 1965), discussions of emotional topics (Almy *et al.*, 1950), cholecystokinin (Harvey and Read, 1973), and prostigmine (Connell *et al.*, 1965). Unfortunately, these motor patterns alone have not proved sufficiently sensitive for diagnostic purposes. Nevertheless, it is now agreed that this syndrome represents a disorder of motility and recent work has suggested that an abnormal colorectal myoelectrical pattern exists (Darby *et al.*, 1977; Snape *et al.*, 1977). In normal subjects visual

analysis of myoelectrical recordings made from the rectosigmoid shows two bands of frequency varying between 0·033-0·066 Hz (2-4 c/m) and 0·1-0·16 Hz (6-10 c/m) (Taylor *et al.*, 1974). The higher frequency predominates in normal subjects, but in patients suffering from the irritable colon syndrome the slower frequencies are present for a significantly greater proportion of recording time. These electrical rhythms are often difficult and time consuming to analyse by eye. To reduce this problem we have chosen to characterise the slow wave activity by means of a real time frequency spectrum analyser. This instrument produces a continuous qualitative estimate of the frequency content of short epochs of slow wave electrical activity.

Using this technique we have studied the specificity of the electrical disturbances in patients referred with the irritable colon syndrome to determine if relapses and remissions of symptoms can be related to alterations in the parameters of colonic motor function.

Methods

Twenty patients referred with the irritable colon

syndrome were studied. These were patients with constant or intermittent lower abdominal pain associated with an abnormality of bowel habit; either the passage of unduly frequent or loose stools or difficulty in defaecation with straining and severe constipation. All appropriate bacteriological and radiological investigations were negative.

By means of a standard questionnaire the symptoms (pain, diarrhoea, and constipation) were scored between 0 and 5 (5 being the most severe symptoms). Five day total stool collections were carried out by the patients and the mean stool weight in grams per day was recorded. Intestinal transit time was measured by Hinton's method (Hinton *et al.*, 1969). This involved the patient swallowing 20 radio-opaque pellets and the following five days stool collection was x-rayed. The time taken for 80% of the pellets to pass was regarded as the transit time.

Slow wave electrical activity was recorded from the rectosigmoid region (8-18 cm from the anus) by means of an intraluminal suction electrode (Taylor *et al.*, 1974). This electrode was introduced into the rectosigmoid through a sigmoidoscope with the subject lying on his or her left hand side. After the electrode had been successfully located on to the mucosa of the colon, the patient assumed the supine position.

After 15 minutes, to allow the effects of the insertion of the mucosal electrode to pass, monopolar recordings were made from the internal electrode and an indifferent electrode placed on the scarified skin on the right thigh. When suitably amplified, the electrical slow wave was characterised by means of a purpose-built frequency spectrum analyser. This instrument, based on two Motorola M6800 microcomputers, produces a frequency estimate for each one minute epoch of slow wave activity and presents it to the clinician in the form of a frequency histogram displayed on a cathode ray oscilloscope. Each one minute frequency histogram was visually examined and a record was made of any frequency component between 1 and 8 c/m having an amplitude above a threshold level set at 20% of the amplitude of the frequency histogram produced by a 10 c/m calibration signal. This enabled the threshold level to be fixed independently of the gain of the instrument. The number of times each frequency occurred was then expressed as a percentage of the total number of epochs—for example, 20 epochs containing 3 c/m activity in a total of 40 epochs constitutes 50% incidence.

Changes in intraluminal pressure were obtained by means of a thin open-ended tube incorporated into the main suction device (Taylor *et al.*, 1974). The percentage motility was calculated by noting the proportion of recording time that pressure waves

were present. The slow wave activity, slow wave frequency estimate, pneumograph, and motility were recorded on a four-channel chart recorder so that permanent records were available to allow retrospective analysis of the data.

Each patient was studied during a symptomatic phase and measurements of each parameter were performed. The patients were then prescribed either an antispasmodic (mebeverine, 200 mg thrice daily) or bran (in the form of bran tablets 12 g/day) for one month. The tests were repeated and the alternative treatment prescribed for another month. The tests were again repeated.

The data obtained after each treatment was completed were compared with the pretreatment values. A proportion of patients were entirely symptom free after one or either of the treatments and particular note was made of the percentage incidence of each rhythm obtained during relapse and remission of symptoms.

Ten normal controls admitted for minor surgical procedures unrelated to the gastrointestinal tract were also studied for comparison and characterisation of slow wave electrical rhythms was carried out using the automatic frequency analyser.

The results in the individual subject during symptomatic and asymptomatic phases were compared using standard statistical analyses (paired *t* test).

Results

NORMAL SUBJECTS

The mean age in these subjects was 42 years (range 27-64 years). There were four females and six males. The mean percentage incidence of each slow wave frequency from the rectosigmoid as recognised on the analyser is shown in Fig. 1. It can be observed that two frequencies were most prominent. The faster slow wave frequency band (6-12 c/m) was present for 78% ± 5·5 (Fig. 2) and the slower one (2-4 c/m) present for 49% ± 10·1. These two electrical rhythms, which were the commonest seen, correspond with the frequencies which have been most clearly recognised on visual analysis (Taylor *et al.*, 1974). The mean percentage motility was 12·5% ± 5·6.

IRRITABLE COLON SYNDROME

Symptoms

Ten patients had predominant constipation and 10 diarrhoea. All had varying degrees of abdominal pain usually referred to the right or left iliac fossa. At the completion of treatment 12 of the patients were entirely symptom free, five were improved, and
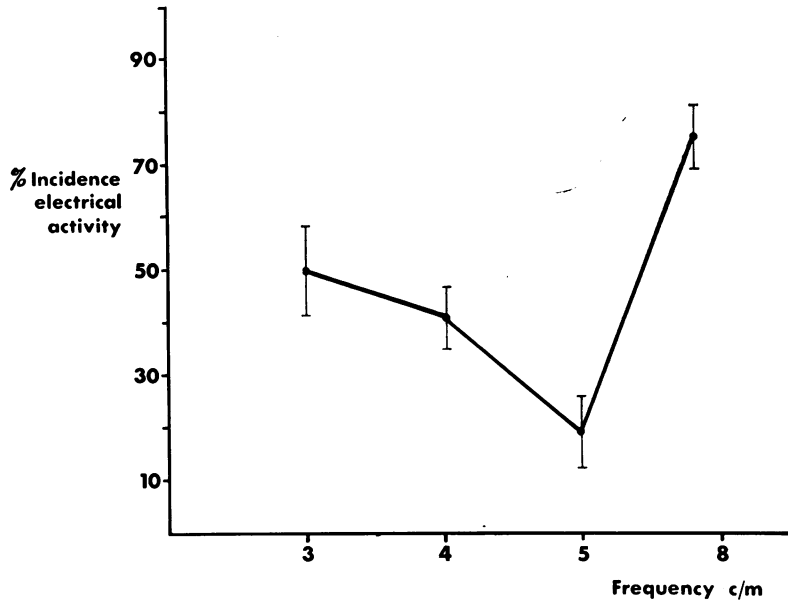
Fig. 1 *Mean percentage incidence of each slow wave frequency in the normal subjects. Two peak incidences are noted at approximately 3 c/m and 8 c/m, although the latter rhythm has the highest incidence.*
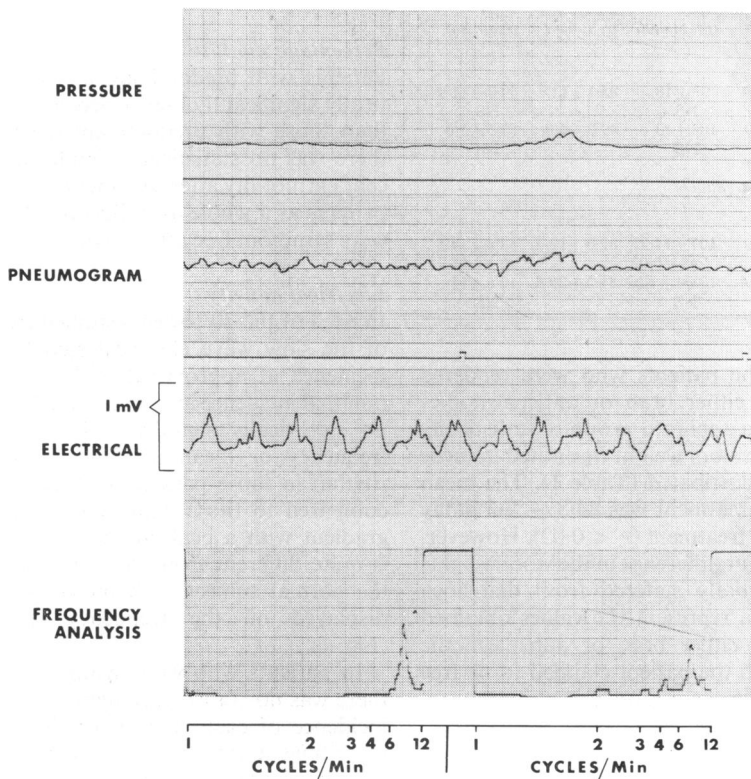

Fig. 2 *Recordings from a normal subject. The top trace represents the changes in intraluminal pressure (each division represents 5 mmHg). The second trace is the pneumogram and below this is the electrical activity from the rectosigmoid (15 cm from anus). Note the predominant wave form with a frequency of 7 c/m. The lower trace shows the frequency analysis of each one minute of data showing a peak at 7 c/m. The markers are at one minute intervals.*

three either no better or worse. Of the 12 symptom-free patients, seven had had diarrhoea and five constipation. On the scoring system for symptoms it was noted that bran was more effective for patients with predominant constipation and mebeverine better for the patients with diarrhoea.

Stool weights

When the patients were considered collectively there was no statistically significant difference in stool weight before and after periods of such treatment (Table 1). This was true both for patients with constipation (79·5 ± 14 g/day before and 93 ± 18 after) and for those with diarrhoea (156 ± 20 before and 108 ± 13 after).

Table 1 *Mean stool weight and mean transit time (± 1 SEM) in patients before and after treatment (with bran or antispasmodics) for two months*

	Mean stool weight (g/day)		Mean transit time (h)	
	Before treatment	After treatment	Before treatment	After treatment
Patients with predominant:				
Constipation	79·5±14	93±18 NS	85·1±11	69·3±11·9 NS
Diarrhoea	156±20	108±13 NS	49·3±6·8	53·5±5·0 NS
Patients symptom free after treatment				
Patients with predominant:				
Constipation	84·8±9·3	107±11·3 P*<0·02	82·0±12·2	53·4±14·5 P*<0·05
Diarrhoea	166±26·4	158·4±12·3 NS	51·2±20·6	49·6±15 NS

*Statistically significant

However, when the patients who were rendered symptom free after either bran or antispasmodics were considered in a separate group a statistically significant increase in stool weight was noted in those who were initially constipated (Table 1). The mean stool weight before treatment was 84·8 ± 9·3 g/day and 107 ± 11·3 after treatment (P < 0·02). However, there was no significant difference in the stool weights in patients who initially suffered from diarrhoea (Table 1). These data represent the values obtained after completion of either bran or antispasmodic therapy during which the patient claimed to be free of symptoms (zero symptom score).

Transit time

There was no statistically significant change in transit time before and after treatment when the group was considered collectively (Table 1). However, when the patients who were symptom free were considered separately, while no statistically significant difference occurred in patients who had suffered with diarrhoea

(51·2 ± 20·6 hours before and 49·6 ± 15 hours after treatment), in the group with predominant constipation the mean transit time was lower after treatment (82 ± 12·2 hours before and 53·4 ± 14·5 hours after, P < 0·05).

Table 2 *Mean percentage motility (± 1 SEM) in patients before and after treatment (with bran or antispasmodics) for two months*

	Percentage motility	
	Before treatment	After treatment
Constipation	17·4% ± 5·3	21·9% ± 8·6 NS
Diarrhoea	7·8% ± 1·5	11·5% ± 3·7 NS
Patients symptom free after treatment		
Constipation	16·4% ± 7·9	24·4% ± 14·4 NS
Diarrhoea	7·6% ± 2·1	10·2% ± 2·8 NS

Percentage motility

Patients with predominant constipation had statistically significantly higher percentage motility values than those with predominant diarrhoea. However, there was no statistically significant change in percentage motility after treatment. This was true for the patients as a whole as well as for those patients who were symptom free after treatment (Table 2).

Electrical activity

In each of the 20 patients studied frequency analysis of the slow wave electrical signals showed a peak incidence at approximately 3 c/m (Fig. 3), and a minimal incidence at approximately 8 c/m. There was no statistically·significant difference in the mean frequency or mean incidence of each slow wave rhythm in those patients with constipation (Fig. 4) compared to those with diarrhoea. This frequency gradient with a peak at the lower frequency range is quite different from the twin peaks recognised in the normal subject both on visual analysis and as displayed on the frequency spectrum analyser (Fig. 1).

In patients who were symptomatically improved there was no statistically significant difference in the incidence of each slow wave rhythm compared to recordings during the symptomatic period, irrespective of whether constipation or diarrhoea (Fig. 4) was the predominant symptom. Similarly, there was no statistically significant difference in the slow wave electrical activity in those patients who were symptomatically better compared to those who showed either no improvement or were worse (Table 3).
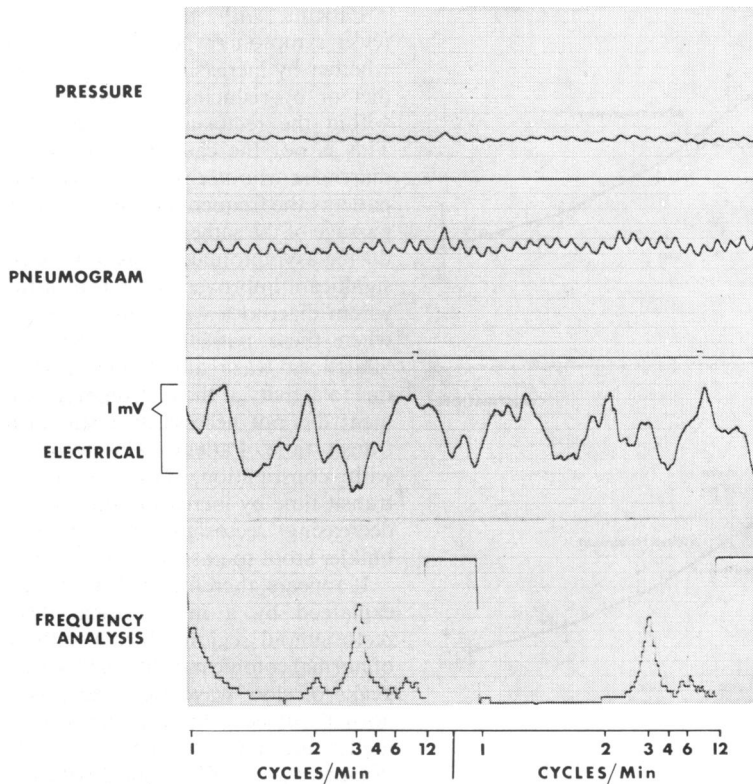
PRESSURE

PNEUMOGRAM

I mV

ELECTRICAL

FREQUENCY
ANALYSIS

2 3 4 6 12   2 3 4 6 12
CYCLES/Min   CYCLES/Min

Fig. 3   *Recording from a patient with the irritable colon syndrome. The top trace*
represents changes in intraluminal pressure (each division represents 5 mmHg).
The second trace is the pneumogram and below this the rectosigmoid electrical
activity (17 cm from anus). The predominant wave form has a frequency of 3 c/m.
The lower trace shows the frequency analysis of each one minute of data illustrating
the peak at 3 c/m. The markers are at one minute intervals.

Discussion

The irritable colon syndrome is a chronic relapsing condition in which the severity of the symptoms may vary from time to time but the nature and character of the symptoms remain constant in any one patient (Waller and Misiewicz, 1969). It is probable that a placebo would have resulted in the same number of symptom-free patients as did bran and mebeverine in this study; however, we were chiefly interested in observing the relationship between symptoms and the parameters of colonic motor function in these patients during relapses and remissions of symptoms. In order to exclude observer bias as much as possible all the parameters measured, stool weight, transit time and slow wave activity, were recorded objectively without knowledge of the clinical status of the patient involved.

Before considering these objective results further, it is important to consider the bowel habit in these patients. True diarrhoea—that is, the passage of over 200 g of faecal fluid per day—was rare although patients frequently referred to this as a predominant symptom. More usually these patients suffered from frequent loose stools throughout the day but in small amounts. Hence they have the frequent desire to defaecate but this results in the passage of small amounts only. This constant urge is probably related to a motor disturbance chiefly in the rectosigmoid region which will be discussed later. Constipation is usually the passage of infrequent hard 'pellets'. Patients with this condition pass small hard stools, which may be painful, often associated with large amounts of mucus. Again this may reflect excess activity within the rectosigmoid region. Accordingly in some patients this rectosigmoid 'spasm', which can frequently be palpated per abdomen or seen on barium enema, results in 'diarrhoea' in some patients, in 'constipation' in others or an individual may alternate between the
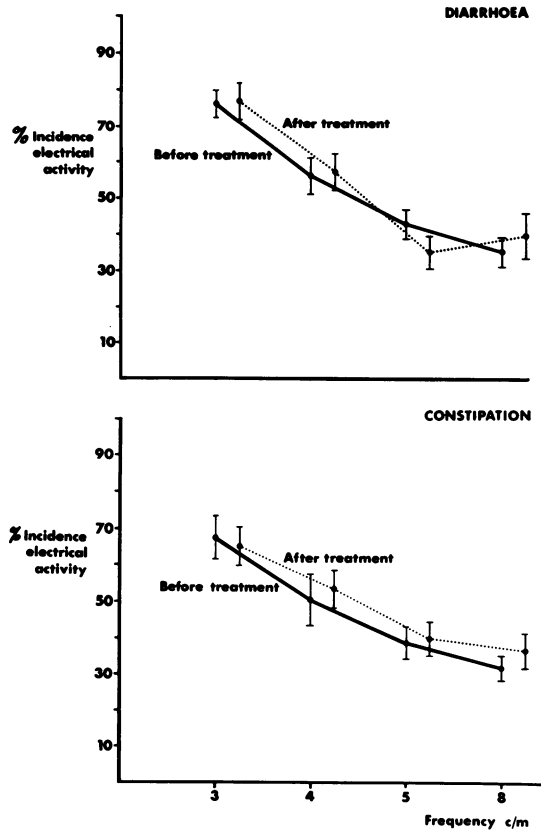
Fig. 4 *The mean incidence of each slow wave rhythm in patients with the irritable colon syndrome. There was no statistically significant difference in the incidence of each rhythm in patients with diarrhoea or constipation. Similarly, there was no statistically significant difference in the incidence of each rhythm before and after treatment in those patients who were symptom free. Note the peak incidence at 3 c/m.*

two. If we consider the results of the objective findings in the light of this hypothesis certain features correlate well.

Patients with predominant constipation have fewer symptoms when the stool weight is increased whether by increasing the cereal fibre content of the diet or by reducing the amount of motor activity within the rectosigmoid (with an antispasmodic). This is not the case in patients with predominant diarrhoea who are rendered symptom free. In these patients the frequent desire to defaecate results in the passage of the same amount of faeces as would occur during asymptomatic phases. Likewise, there was no significant improvement in transit time in patients in whom diarrhoea was a predominant symptom even when these patients were symptom-free, as this 'diarrhoea' was really an increased urge to defaecate due to activity at the rectosigmoid level and improvement did not necessarily result in an alteration in transit time. Patients who were initially troubled with constipation, however, can decrease their transit time by increasing the amount of bulk or by decreasing rectosigmoid activity, so allowing a bulkier stool to pass more frequently.

It appears, therefore, that these parameters may be explained by a myoelectrical disturbance in the rectosigmoid region which results in incordination of normal colonic motility in this area. Instead of two peaks of slow wave frequency, as is recognised in normal subjects, these patients have a significantly higher incidence of the slower electrical rhythm (Snape *et al.*, 1977) coupled with a lower incidence of the faster rhythm (Darby *et al.*, 1977).

Each subject had three sets of measurements of myoelectrical activity performed over a two month period and no statistically significant difference in the incidences of the slow wave rhythms occurred during either symptomatic or asymptomatic phases (Fig. 4). This is unlike the situation in diverticular disease where there is a return of the normal myoelectrical activity towards normal during asymptomatic phases (Taylor and Duthie, 1976).

Visual analysis of colonic slow wave electrical activity is time consuming, whereas automatic on-line frequency estimation is useful both in reducing analysis time and providing improved repeatability.

Table 3 *Mean percentage incidence of each slow wave frequency (± 1 SEM) before and after treatment (with either bran or antispasmodics) for two months*

| | Percentage incidence of each slow wave frequency (± 1 SEM) | | | | | | | |
| | Before treatment Frequency c/m | | | | After treatment Frequency c/m | | | |
	3	4	5	8	3	4	5	8
Constipation	67·8 ± 5·3	50·7 ± 7·4	39·8 ± 3·3	31·0 ± 2·5	65·0 ± 6·3	53·9 ± 4·8	39·4 ± 5·9	36·9 ± 5·3
Diarrhoea	75·3 ± 2·9	55·8 ± 5·1	42·8 ± 2·8	37·7 ± 3·1	73·5 ± 5·5	55·1 ± 6·2	34·3 ± 6·4	40·9 ± 6·4
Patients symptom free after treatment								
Constipation	67·0 ± 6·6	51·6 ± 4·1	42·3 ± 3·7	35·5 ± 4·2	63·3 ± 8·0	55·2 ± 3·8	52·7 ± 3·9	41·7 ± 7·1
Diarrhoea	80·5 ± 2·6	62·3 ± 11·7	47·0 ± 3·8	34·0 ± 3·8	74·8 ± 8·7	53·8 ± 6·7	40·0 ± 8·9	42·7 ± 9·1

In this comparative study between normal subjects and patients with the irritable colon syndrome, a fixed threshold was used to determine the presence of frequency components. It may be possible to improve this classification technique by including the amplitude of the frequency component of each frequency histogram in the analysis.

These findings would suggest that, in patients with the irritable colon syndrome, a basic abnormality of disordered smooth muscle myoelectrical function is present which persists after treatment. The chronic relapsing nature of the syndrome could be explained by this consistent abnormality which remains even when patients are relatively symptom free.

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