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Colonic myoelectrical activity in IBS painless diarrhoea

J FREXINOS, J FIORAMONTI, AND L BUENO

From the Service de Nutrition et de Gastroenterologie, Centre Hospitalier Universitaire de Rangueil, Toulouse, Departement de Pharmacologie INRA, Toulouse, France

SUMMARY Colonic myoelectrical activity was recorded during 24 hours in 23 patients with painless diarrhoea and compared with a control group of 10 healthy subjects without digestive functional disorders. Diurnal fasting activity showed no significant difference in the total long spike bursts activity (LSB lasting >7 seconds), but short spike bursts activity (SSB, lasting <7 seconds) was significantly lower ($p<0.05$) in diarrhoeal patients. A striking difference was observed in colonic response to eating, with an increased number of migrating long spike bursts (MLSB: mass movements) during the first postprandial hour in diarrhoeal patients ($p<0.001$), while short spike bursts (segmental activity) were almost absent in the rectosigmoid area. A marked decrease in the retrograde LSB activity was also observed in eight patients. During the night (from 2200 h to 0600 h) the number of migrating long spike bursts was increased in the diarrhoea group, but almost absent in controls ($p<0.001$). This study shows that colonic motor activity was altered in painless diarrhoea. These disturbances were not limited to the decreased SSB activity in the sigmoid, but involved the whole colon, with lower SSB activity and abnormal increase of migrating long spike bursts activity (MLSB) in postprandial and nocturnal periods.

Painless diarrhoea has been recognised as a separate entity, among the subgroups of irritable bowel syndrome (IBS) in 1962.[1] It has been suggested that changes of colonic motility that sometimes accompany this symptom result in low levels of colonic segmenting pressure activity whilst constipated subjects have high levels of segmentation.[2] The previous studies, however, reported changes affecting intraluminal pressures of the pelvic colon over a few hours. Because of the great diurnal variations in colonic motility even in healthy subjects,[3] the purpose of this study was to investigate colonic myoelectrical activity over 24 hours in a homogeneous subgroup of IBS patients and to compare the results with those of a control group investigated under the same conditions.

Address for correspondence: Prof J Frexinos, CHU de Rangueil, 31054 Toulouse, France.

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Methods

SUBJECTS

Ten healthy volunteers (seven men, three women, 25-35 years) who had not complained of gastrointestinal symptoms, had not taken laxatives for at least three years and any other medication for at least three weeks were used as control group. The absence of colonic lesions was endoscopically confirmed during positioning of the probe. Data obtained from this control group are already published.[3]

Twenty five patients (15 men, 10 women 23-67 years) complaining of painless diarrhoea for at least six months were drawn from 92 referrals to the Nutrition and Digestive Diseases Service of Rangueil University Hospital for colonic electromyography for functional bowel diseases. The protocol of this study was approved by the Ethical Committee of the Faculty of Medicine, and investigations were carried out from March 1984 to March 1986. The patients were selected according to the following criteria after giving informed consent: painless diarrhoea with an

increase in bowel frequency to four or more times/day (the stools being semisolid or watery) and a stool weight exceeding 200 g/day or a total transit time less than 18 hours, measured according to the method of Hinton *et al*,[4] (assessment as an outpatient before study): absence of detectable organic disease by haemogram, blood chemistry, gastroscopy, and colonoscopy; absence of any other cause of chronic diarrhoea; thyroid diseases, lactose intolerance, carcinoid, Zollinger Ellison syndrome, were eliminated by appropriate investigation (plasma T3, T4, TSH, serotonin, calcitonin and gastrin, as well as breath hydrogen test with lactulose).

RECORDING SYSTEM

The probe used to record myoelectric activity was made of a polyvinyl tube, 0·5 cm in diameter, 150 cm in length and supported eight groups of three annular electrodes placed at 4 mm intervals. A full description of the probe is published elsewhere.[3] Bipolar recordings were made with an eight channel electroencephalograph (Minihuit ALVAR) using a time constant of 0·03 s and a paper speed of 7·2 cm/min.

SIGNAL ANALYSIS

The signals arising from four electrodes sites were quantitatively analysed using a battery powered microcomputer EPSON HX 20, with an integral printer and microcassette unit.[5] The computer discriminated between different types of spike bursts on the basis of their respective durations (LSB more than 7 seconds, SSB less than 7 seconds) and measured their incidence at each electrode during successive 30 min periods during the entire recording. A histogram corresponding to the quantitative incidence of SSB and LSB activity for four channels was printed at 12 hour intervals and stored on microcassette. Visual analysis was, however, required to evaluate the propagation of long spike bursts and was done by the same observer who was unaware of the clinical status of the subject. Values were expressed as mean ±SEM and comparison between values observed in IBS patients and controls were carried out by Student's *t* test.

RECORDING SESSION

All subjects, free of drugs for at least three days, were fasted for 14 hours before monitoring and careful bowel cleansing was carried out with an enema 12 hours before the probe was introduced into the colon by means of a colonoscope. A thread attached to the tip was used to pull the probe to the caecum under direct visual control. During the withdrawal of the endoscope, organic disease was excluded by careful examination. During endoscopy, intravenous injections of fentanyl (0·1 mg) and diazepam (10 mg) were used if necessary. They were followed by an injection of naloxone (0·4 mg) immediately after the end of the endoscopy.

Usually the probe was placed at 9 am and in order to eliminate any possible effect of colonoscopy, enema, air insufflation or medications, recording sessions began at 5 pm, seven to eight hours after placement of the probe. Thereafter the subjects remained supine on a bed over the following 24 hours; sleep was not permitted during the daytime. A 800-1000 calories meals was given at 7 pm on the first day and noon on the second day. Each meal provided approximatively 400 calories of fat, 300 calories of carbohydrates and 200 calories of proteins.[3] The time taken to eat the meal, about 30 minutes, was similar in the two groups. A continental breakfast (less than 200 calories) was given at 8 am on the second day. The position of the probe was checked radiographically 15 hours after the start of the recording.

Results

Twenty three colonic recordings were done. Apart from two patients in whom the probe was ejected by a bowel movement a few hours after insertion into the colon, the 24 hours monitorings were well tolerated. Three other patients had a bowel movement during the recording session but the probe was not rejected. Among the 23 patients with complete 24 hour recordings, nine had a group of electrodes located in the rectosigmoid area. The tip of the probe was placed into the sigmoid in two cases, reached the left colonic angle in nine patients, the right flexure in eight and the caecum in four.

Two kinds of spike bursts were observed in the control group and the IBS group. The first consisted of short spike bursts (SSBs) lasting 3·1 s +/− 0·4 s usually recurring rhythmically at an average rate of 10·6 +/− 0·3/min. These bursts always appeared to be localised at one electrode site without any propagation to an adjacent group of electrodes. The second consisted of long spike bursts (LSBs) lasting 10·3 +/− 3·6 s in one of the three different patterns: (a) localised at one electrode site, (b) propagated over a short distance (17-68 cm) in aboral or oral directions, (c) migrating LSBs (MLSBs) rapidly propagated in the aboral direction over the whole length of the colon, most evident as the colonic response to eating (Figure).

DIURNAL FASTING ACTIVITY

The comparison of total values of diurnal fasting spiking activity (from 5 pm to 7 pm) expressed as per cent of time for LSB activity indicated no significant difference ($p>0·05$) between IBS patients with diarrhoea and controls. In contrast the mean duration

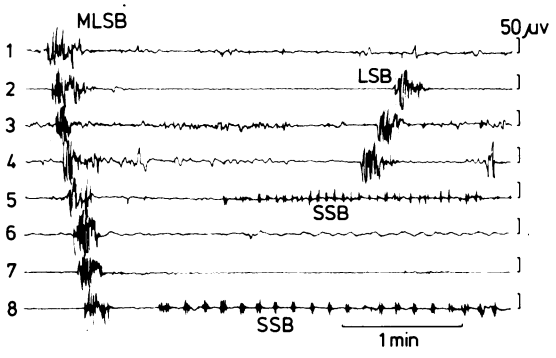

Figure *Representative electromyogram obtained in a patient from the right colon (1) to the rectosigmoid junction (8) showing the different kinds of spike bursts: short spike bursts (SSB) at the 5th and 8th electrode sites, long spike bursts (LSB) orally propagated over 3 electrodes sites or rapidly propagated over the whole colon (migrating long spike burst, MLSB).*

of total SSB activity was significantly lower in painless diarrhoea patients but because of the great variability of such activity, no significant difference appeared for each part of the colon (Table 1). Short spike bursts were present in the descending and sigmoid colon of all the 10 control subjects, however, while they were not detected in 13 of the 21 diarrhoeal patients in whom recording of the descending and sigmoid colon was successful.

COLONIC RESPONSE TO EATING

Migrating LSBs (MLSBs) appeared shortly after the beginning of the meal and during the first postprandial hour, their number was significantly higher ($p<0.001$) in IBS patients compared with the control group (Table 2). These MLSBs appeared propagated from the caecum (or the right flexure) to the sigmoid colon at a velocity of 10·5+/−3·2 cm/s similar to that observed in the control group (9·3+/−2·4 cm/s). Such an increase in MLSB activity appeared after both dinner and lunch (800-1000 Kcal) but not after the breakfast (less than 200 Kcal); except in five IBS patients who exhibited three to six MLSB during the first hour after breakfast. Moreover, while all the control subjects exhibited a retrograde activity (more than four LSB orally propagated during the three postprandial hours over at least three electrode sites), eight among the 21 painless diarrhoea patients exhibited no (three patients) or few (five patients) retrograde LSBs (Table 3).

NOCTURNAL SPIKING ACTIVITY

In the two groups the lowest values of LSBs (expressed in per cent of time) were observed from 10 pm to 6 am. During this nocturnal period, the mean duration of SSB activity (expressed in per cent of time) was significantly lower ($p<0.05$) in the IBS patients (0·9 +/−0·7% *v* 3·1+/−1·4% in controls). In control subjects, MLSBs aborally propagated over the whole length of the investigated colon, were nearly absent

Table 1 *Diurnal fasting activity (per cent of time, mean±SEM) during the two hours before the dinner (5-7 pm) in healthy volunteers and painless diarrhoeal patients*

	Ascending		*Transverse*		*Descending*		*Sigmoid*		*Whole colon*	
	LSB	*SSB*	*LSB*	*SSB*	*LSB*	*SSB*	*LSB*	*SSB*	*LSB*	*SSB*
Healthy volunteers	7·1 ±1·6	2·1 ±1·9	8·3 ±1·7	3·1 ±3·3	9·8 ±2·6	2·6 ±2·7	8·5 ±1·7	2·4 ±1·9	8·4 ±1·1	2·5 ±0·4
	n=4		n=10		n=10		n=7			
Painless diarrhoea	8·6 ±1·9	1·7 ±1·2	6·9 ±2·4	1·7 ±1·7	9·9 ±3·2	1·4 ±1·3	10·4 ±2·6	1·1 ±1·3	8·9 ±1·6	1·4* ±0·3
	n=4		n=12		n=21		n=23			

*Significant difference ($p<0.05$) between the groups.

Table 2 *Number of migrating long spike bursts (mean±SEM) during the three hours after each meal in healthy volunteers and painless diarrhoea patients*

	Dinner			*Lunch*		
Postprandial (hours)	*1st*	*2nd*	*3rd*	*1st*	*2nd*	*3rd*
Healthy volunteers (n=10)	2·9±0·6	3·8±0·5	3·5±0·6	2·5±0·6	3·6±1·0	4·3±1·1
Painless diarrhoea (n=12)	8·7±3·6*	4·7±2·8	3·1±0·8	7·3±2·4*	3·0±1·4	2·6±0·9

*Significantly different ($p<0.001$) from values in healthy volunteers during the same period.

Table 3 *Retrograde activity in control and painless diarrhoeal patients. Number of subjects presenting less than four, four to eight and more than eight orally propagated LSB during the three hours after meals*

(Number of retrograde LSB*)	<4	4-8	>8
Healthy volunteers†	0	8	2
(n=10)		(80%)	(20%)
Painless diarrhoea	8	13	0
(n=21†)	(38%)	(62%)	

*Corresponds to LSB orally propagated over three or more electrodes sites; †subjects with the tip of the probe located at the left colonic angle or above.

during night time (1·9+/−1·8 MLSBs for eight hours from 10 pm to 6 am). In painless diarrhoeal patients the number of MLSBs was significantly ($p<0·001$) higher during this period (6·1+/−2·4 MLSBs).

COMPARISON OF SPIKING ACTIVITY AT DIFFERENT COLONIC SITES

In normal subjects no significant difference was found between the different colonic sites except for a lower SSB frequency (6·7+/−0·4/min) in the rectosigmoid area; this frequency was different from that in the ascending, transverse, and descending colon. In the nine painless diarrhoeal patients having a group of electrodes in the rectosigmoid area, we did not observe SSBs at this peculiar frequency and, as for the other colonic sites, SSB activity as expressed in per cent of time, was lower ($p<0·05$) than in controls.

Discussion

Over the last 10 years, many studies have been devoted to the search for a pathophysiological marker of the irritable bowel syndrome (IBS). The discrepancies of the results and the absence of any positive conclusion could be explained in part by differences and insufficiencies in the recording methods and also by the heterogeneity of functional bowel diseases. Moreover, most of the manometric and electromyographic studies were of short duration and confined to the rectosigmoid colon. Recording myoelectrical activity from the entire colon over 24 hours is needed to ensure that intermittent or paroxysmal changes are not missed. Truly physiological conditions were not obtained as an empty colon was required for the initial colonoscopy and recordings were done on supine subjects. In order to reduce the possible effects of air insufflation and drug injections, an adaptation time of eight hours was imposed between the colonoscopy and the beginning of the recording session.

This study provides evidence for two peculiar patterns of myoelectrical activity in patients complaining of IBS with painless diarrhoea as compared with healthy subjects.

The first is a marked reduction or complete absence of SSBs bursts. An earlier study of colonic myoelectrical activity in health and functional disorders showed low SSB activity in six diarrhoeal patients in whom sigmoid activity was recorded over 10 hours.[6] The SSBs have been shown to be associated with no propagated contractions of small amplitude.[6] They correspond to the discrete electrical response reported by Sarna *et al*[7] and the rhythmic spike potential reported by Schang and Devroede.[8] In normal subjects they can be seen intermittently at any site in the entire colon, predominantly with a characteristic frequency in the rectosigmoid area.[3] The marked SSB activity at this level suggests the presence of a hyperactive segment acting as a 'brake'. Furthermore, manometric recordings in the human colon revealed the presence of a hyperactive pressure zone at the rectosigmoid junction in constipated subjects and more rarely in normal subjects[9] in agreement with myoelectrical records.[6] All of this evidence suggests that sigmoid motor activity allows for further fluid absorption and storage and is important in the maintenance of normal bowel habits by preventing premature passage of liquid stool in the rectum.[10]

Our results are in agreement with those previously reported by others,[2 11 12] who found a resting sigmoid tone decreased in diarrhoea and increased in constipation. This has led to the hypothesis of paradoxical motility of the colon in constipation and diarrhoea. In contrast, our data are at variance with the observations reported by Whitehead *et al*[13] who found more frequent fast contractions in diarrhoeal dominant IBS patients than those with constipation. Their patients, however, had diarrhoea associated with a painful abdomen, while those in other studies tended to have painless diarrhoea, and their methods of studying motility by graded distension of the rectosigmoid may have led to different results.

The second interesting finding is that colonic response to eating was greater in painless diarrhoea patients than in controls with an increase in the total number of MLSBs. Moreover in eight patients, a decreased number of retrograde MLSBs was observed. Those data are in agreement with previous experimental studies which have shown that induction of defecation in the dog by the administration of mannitol or overfeeding was associated with an increase in the frequency of propagative LSB.[14 15] Laxatives, cholinergic agents, guanethidine, infusion of 25% glucose into the ileum in dogs, generated giant migrating contractions and mass movements.[16] In man propulsive movements have also been induced

by administration of enemas,[17] laxatives[18] and by steady state perfusion of fluid into the caecum.[19] Colonic transit time has been shown to be shorter in patients with IBS complaining of diarrhoea, than in normal subjects.[20]

All these findings are in agreement with our results and it is likely that an exaggerated stimulation associated with an unusually great increase in colonic propulsive activity represents the inappropriate response to eating in painless IBS diarrhoea. The rapid occurrence of this response suggests a nervous rather than a single humoral pathway although some hormonal levels[21] were found to be increased in such cases.

Our observations suggest that colonic motor activity is altered in painless diarrhoea and that disturbances not only bear on the sigmoid colon, which may be incompetent as a result of a reduction in non-propagated myoelectrical activity, but also on the whole colon with an abnormal increase of MLSB activity in response to food intake.

Abnormal colonic motor activity cannot be clearly shown as the unique cause of painless diarrhoea in IBS, however. Acceleration of transit time through the small intestine was found in patients with IBS who complained of painless diarrhoea.[22,23] Other results[24] suggest that IBS is a paroxysmal motor disorder which may be detected in the small bowel and which may be either spontaneous or evoked. Ileal peristasis was correlated closely with symptoms in IBS and dysmotility of the small bowel was demonstrable if recordings were prolonged and included the ileocaecal region.[25]

The production of diarrhoea in a variety of animal species has been associated with the preponderance of a pattern, which has been called 'minute rhythm', and consisting of regular groups of contractions occurring at intervals of between one and two minutes, separated by periods of quiescence and propagated distally.[26]

An abnormal increase in the delivery of fluids, electrolytes and nutrients to the colon, caused by an abnormality in small intestinal transit time or reduction in epithelial fluid transport can therefore overcome the ability of the colon to absorb this extra load,[27] and this will result in diarrhoea if the colon is unable to absorb this excess volume. A 'vicious spiral' (fluid secretion – propulsion – rapid transit – diminished absorption – more fluid – propulsion – diarrhoea) has been proposed[27] and may start with primary abnormalities in either motor activity or epithelial transport of colon and small intestine. Results of this study providing evidence for marked colonic dysfunction, shed some light on the multifactorial pathogenesis of painless diarrhoea in IBS patients.

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