

## *Alimentary tract and pancreas*

# Colonic mass movements in idiopathic chronic constipation

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**SUMMARY** - As relatively little is known of human colonic motor activity either in health, or in pathological conditions, we investigated mass movements in 14 chronically constipated patients and 18 healthy volunteers. Mass movements were recorded from proximal and distal colon during 24 h (12 noon-12 noon) by a colonoscopically positioned multilumen manometric probe and low compliance infusion system. Patients and controls differed significantly in the number (mean 2.6 (0.7) v 6.1 (0.9) (SE),  $p=0.02$ ) and duration (mean 8.2 (1.6) v 14.1 (0.8) s,  $p=0.04$ ) of mass movements. The data suggest that one pathophysiological mechanism of constipation may be decreased propulsive activity. A circadian pattern, with a significant difference between day and night distribution, was documented in both groups. The patients reported decreased defecatory stimulus concomitant with the mass movements.

The pathophysiological mechanisms responsible for chronic constipation are poorly understood,<sup>1-6</sup> probably because of the scanty information available on normal colonic activity. Because most studies on constipated patients have been done in the recto-sigmoid area,<sup>4,6,7</sup> this is particularly true of the proximal tract.<sup>8-11</sup> Techniques have now been developed, however, that also permit the investigation of proximal colon myoelectric<sup>12</sup> and manometric<sup>13,14</sup> activity.

We have studied certain specific colon events, the so called mass movements (MM) - a term used to define a vigorous propulsive activity that dislocates colon contents peristaltically over a long tract of the large bowel in an oro-aboral direction.<sup>15-17</sup> Although MM were first discovered by radiological techniques in the early 1900's<sup>15,16</sup> the description of their manometric equivalents and characterisation in the intact colon of healthy subjects is a relatively recent achievement.<sup>13,18</sup>

The lack of pathophysiological data pertinent to intraluminal activity<sup>5,8,9,19</sup> was the motive for the present study, which was undertaken to detect and characterise MM in chronically constipated patients.

## Methods

### PATIENTS

Inclusion criteria were: (1) history of longstanding (more than nine months) constipation; (2) one or fewer weekly bowel movements; (3) no secondary causes of constipation, which were excluded by drug history, physical examination and laboratory screening (blood chemistry, oral glucose tolerance test, thyroid and sex hormone profiles, antinuclear antibodies); (4) no history of previous abdominal surgery other than appendectomy or cholecystectomy. In order to exclude organic disease or mechanical causes of constipation, each patient underwent double contrast barium enema, upper gastrointestinal series, abdominal sonograms, upper fibre-optic panendoscopy and total colonoscopy. Absence of Hirschsprung's disease was proved by normal relaxation of the internal anal sphincter at anorectal manometry (see 20 for method). Proctometrogram recording<sup>20</sup> showed that no patient had megarectum which could have led to rectal stasis. Three patients with doubtful histories of chronic intestinal pseudo obstruction were further studied by oesophageal, gastric and small bowel manometric examination carried out by a previously described technique.<sup>20-22</sup> The results showed that two had normal motility

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Table 1 Some characteristics of patients under investigation

Patient	Sex	Age	Symptoms duration (yr)	Abdominal pain	Laxative consumption	Weekly evacuation	Recto-anal inhibitory reflex
PP	F	39	>20	yes	yes	<1	present
PS	F	21	3	no	yes	<1	present
GA	F	40	9	no	yes	1	present
TD	F	17	15	yes	no (enemas)	<1	present
VI	F	44	10	yes	yes	<1	present
VV	F	35	>20	yes	no (enemas)	1	present
PL	F	56	>20	yes	yes	<1	present
AC	F	47	7	yes	yes	<1	present
PM	F	55	>20	no	yes	<1	present
TM	F	47	>20	yes	yes	<1	present
MG	F	46	10	no	yes	<1	present
CE	M	32	1	yes	yes	1	present
AD	F	32	10	no	yes	<1	present
CL	F	21	1	yes	yes	<1	present

patterns, but that the third had high amplitude esophageal peristaltic contractions.

All 14 patients (13 women, one man, median age 39.5 years, range 17–56) fulfilled the inclusion criteria and were diagnosed as having idiopathic chronic constipation. Some patient characteristics are listed in Table 1. History of constipation ranged from one to more than 20 years, and all but two subjects had been unsuccessfully treated (or self-treated) with bran and various laxatives for a long time before being referred to our laboratory. Two patients had undergone cholecystectomy without sequelae.

After a careful explanation about the aims of the study, each patient gave informed consent, and the investigations were conducted according to the recommendations of the Helsinki Declaration.

Intestinal transit time (ITT) and 24 hour manometric recordings were scheduled after three weeks without laxatives. To limit exposure to radiation, ITT was carried out by a simplified technique. Briefly, after ingestion of 40 radiopaque markers (obtained by cutting radiopaque PVC nasogastric tubes) plain abdominal radiographs were obtained at 96 and (if the first was pathological) at 168 hours. The normal upper limit for our laboratory is fewer than 80% of ingested markers still present after 96 hours.

Prolonged manometric recordings were done by a previously described technique.<sup>13,14</sup> After bowel cleansing (semiliquid diet for two days, 30 g magnesium sulphate by mouth 36 hours before the procedure, two tap water enemas 12 and two hours before beginning the study), an open tipped 8-lumen PVC manometric catheter with the recording ports spaced 12 cm apart (Arndorfer Medical Specialties, type ESM special extra length M3, outer diameter 4.5 mm, inner diameter 0.8 mm for each lumen) was introduced into the colon by a colonoscope (Olympus

CF-10 L). Premedication for endoscopy consisted of 10 mg diazepam intravenously. The manometric probe was introduced up to the ascending colon by advancing it together with the colonoscope by a silk thread held by biopsy forceps inside the operational channel of the colonoscope. Once the caecum or the ascending colon had been reached, the biopsy forceps were opened and the endoscope gently withdrawn, leaving the catheter *in situ*. During colonoscope withdrawal, air was aspirated as completely as possible.

The patient then recovered for three to five hours and was radiographically checked by injecting 2 ml radiopaque contrast through the first channel of the probe. Another radiographic control was done at the end of the recording session (total radiation exposure to the gonads about 30 mrem). Intraluminal pressures were recorded by external physiological pressure transducers (Bell & Howell, type 4-327-I) coupled to a multichannel Beckman R-611 Dynograph Recorder (until January 1987 we had four channels available, then the last five patients were recorded on a 8-channel system). The lumens of the probe were constantly perfused with bubble-free distilled water at 0.1 ml/min (water volume infused during 24 hours about 580 ml) by a low compliance pneumohydraulic pump (Arndorfer Medical Specialties). At this perfusion rate, this system yields a pressure rise to distal occlusion of more than 130 mmHg/s.<sup>13,14</sup>

Manometric recordings were carried out during a 24 hour period (12 noon to 12 noon) with the subjects lying on a comfortable bed in a quiet room. Two 1000 kcal standard mixed meals, that have been previously shown to stimulate colon motility<sup>13,14,23-25</sup> were served at 2 and 8 pm. A continental breakfast (450 kcal) was served at 8 am. During the recording session, patients were instructed to signal on the tracing with a manual

marker any need to defecate or abdominal discomfort that occurred.

Eighteen healthy volunteers (13 men, five women, aged 22–35 years), who were studied in the same way, served as controls.<sup>18</sup> Eight had also entered a previous investigation on colon motor function.<sup>13</sup>

#### DATA ANALYSIS

All tracings were analysed visually by one of the authors (GB), in order to minimise bias caused by interobserver variability. Mass movements were defined as clearly identifiable high amplitude peristaltic waves propagated over two or more recording sites.<sup>13</sup> The following MM parameters were taken in account: (a) number/subject/24 h; (b) origin; (c) propagation (oro-aboral or *vice versa*); (d) amplitude, in mmHg, calculated by subtracting mean resting colon pressure from the peak of pressure waves; (e) duration, in seconds; (f) propagation velocity, in cm/s, considered as the time between peristaltic wave peaks from adjacent transducers; (g) daily distribution.

#### STATISTICAL ANALYSIS

Differences in amplitude, duration and propagation velocity of MM between patients and controls were analysed with the Mann-Whitney U test. The numbers of MM in patients and controls were compared by two-way variance analysis with one repeated measure after transformation of the data [SQR (n+0.5)] to obtain normalisation.<sup>26</sup> Daily distribution and time course of MM were analysed with the Cochran Q test, taking into account the percentage of subjects with MM at each time interval.<sup>27</sup> Calculations were made with the NWA STATPAK statistical package.<sup>28</sup> Values of p less than 0.05 (two-tailed) were considered significant. All values are expressed as means (SE).

## Results

#### INTESTINAL TRANSIT TIME

Results are summarised in Table 2. It is worth noting that ITT was prolonged beyond 96 hours in nine patients (64%) and that seven (50%) had pathological retention of the markers after 168 hours (seven days). Markers were distributed throughout the entire large bowel in four of these nine patients (Figure 1), whereas in the other five they were concentrated in the left colon or the rectum (Table 2).

#### CATHETER POSITIONING

The tip of the probe was seen in the transverse colon in 10 patients and in the descending colon, immediately below the splenic flexure, in the remaining four;

Table 2 Intestinal transit time (ITT, expressed as percentage of markers retained) and mass movements (MM) presence in patients under investigation

Patient	ITT 96 h	ITT 168 h	Colonic site of markers' retention	MM
PP	45%	ND	—	yes
PS	>80%	>80%	whole colon	yes
GA	60%	ND	—	yes
TD	80%	65%	left colon and rectum	yes
VI	>80%	80%	left colon	yes
VV	40%	ND	—	yes
PL	>80%	>80%	whole colon	yes
AC	>80%	>80%	whole colon	no
PM	>80%	>80%	whole colon	no
TM	15%	ND	—	no
MG	50%	ND	—	yes
CE	>80%	>80%	rectum	yes
AD	>80%	>80%	rectum	yes
CL	>80%	10%	rectum	no

ND=not done.

whereas, in the control group, it was observed in the ascending colon of two and the transverse colon of 16 subjects. Increased sliding of the probe from the

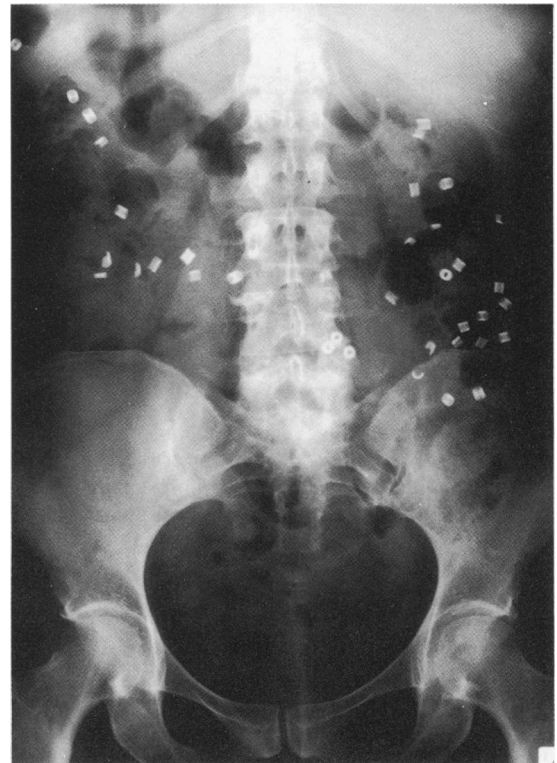


Fig. 1 Plain abdominal film of intestinal transit time in a chronically constipated patient, showing more than 80% retention of ingested markers after 168 h.

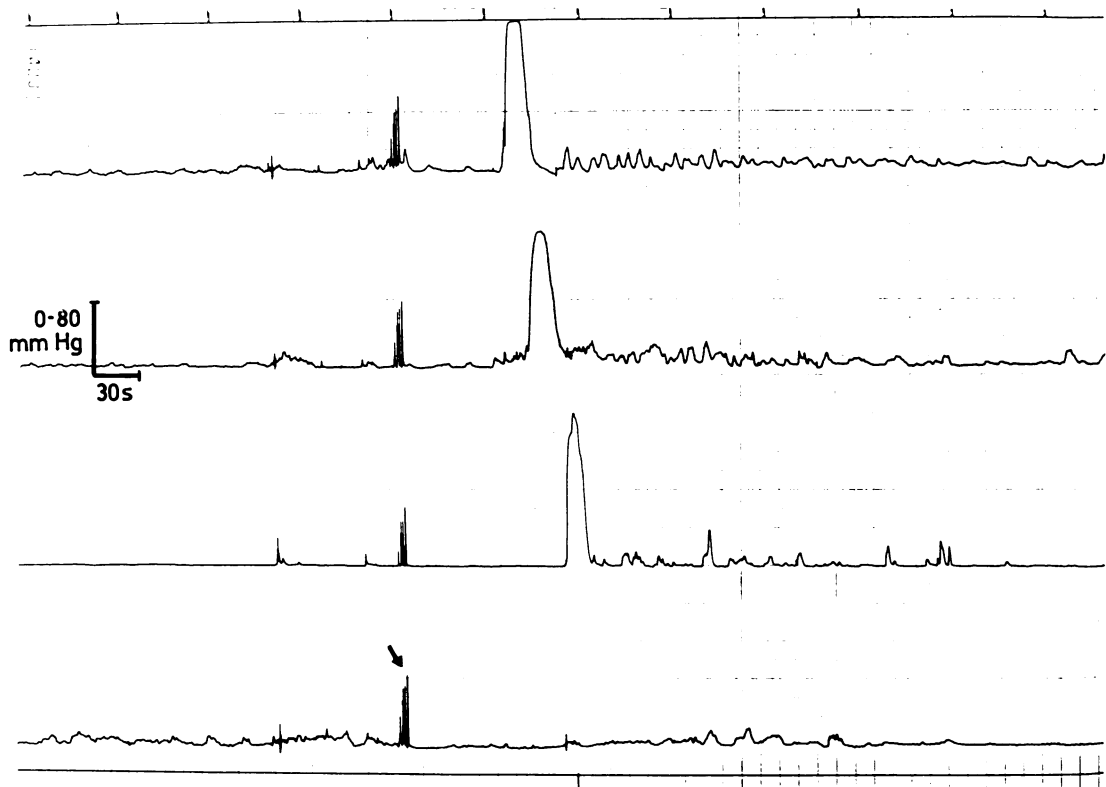


Fig. 2 Representative tracing of a mass movement in a constipated subject. Note the oro-aboral propagation from the distal transverse (first tracing) to the distal descending (third tracing) colon. The arrow shows an artefact. Note the striking difference between peristaltic and other kinds of colon contractions.

ascending colon during colonoscope removal, due to patients having a more complex anatomical structure, probably accounts for the between groups differences.

#### CATHETER DISPLACEMENT

The probe was displaced more than 10 cm due to kinking in one patient. After 18 h of recording, this caused such intense abdominal cramps and pain that the session had to be stopped (see below). A similar degree of displacement was documented in two controls after defecation.

#### MANOMETRY

Mass movements were recorded for 10 (71%) patients and 18 (100%) controls ( $p=0.03$ ). Overall, 36 MM were registered for constipated subjects and 110 for controls; means were 2.6 (0.7)/subject/24 h for patients and 6.1 (0.9)/subject/24 h for controls ( $p=0.02$ ). Mass movements originated in the more proximal colon segment in both groups and propagation was always towards the anus (Fig. 2). Mean

amplitude of MM was 87.6 (16.2) mmHg for patients and 110.4 (6.4) mmHg for controls ( $p=ns$ ), mean duration was 8.2 (1.6) s for constipated patients and 14.2 (0.8) s for controls ( $p=0.04$ ), while propagation velocity was not significantly different in the two groups (1.0 (0.3) v 1.1 (0.1) cm/s,  $p=ns$ ). Mass movements were more frequent during the day than at night and the % subjects who manifested MM between 6 am to 2 pm was significantly greater than those who did so between 4 pm to 4 am in both groups (patients  $p<0.005$ , controls  $p<0.001$ ) (Fig. 3). Since the appearance of MM did not differ greatly in the two groups during these time periods, it would seem that they fluctuate casually in both. Mass movements increased after meals and, even more so, on awakening in the morning (Fig. 3). Similar data have been reported for healthy subjects.<sup>13,18</sup> Variance analysis showed that daily MM fluctuations were parallel in the two groups (Fig. 3).

#### SUBJECTIVE FEELINGS

All control subjects reported more or less intense

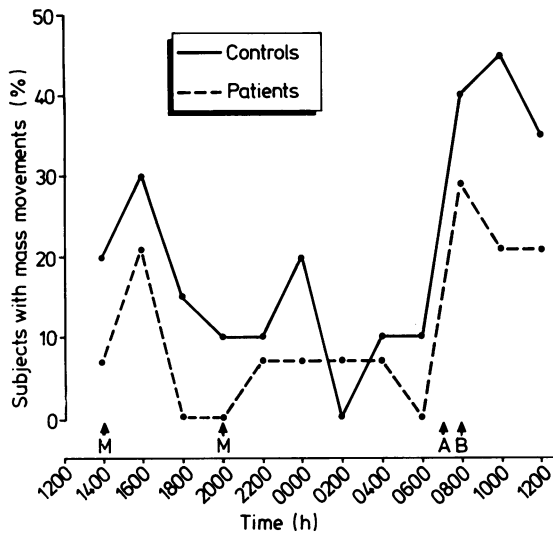


Fig. 3 Daily distribution of mass movements (expressed as hourly percentage) in patients (broken line) and controls (solid line). Note the increase in incidence following meals and on awakening in the morning, and the reduction during the night. M=standard meal; A=awakening; B=breakfast.

abdominal discomfort and/or crampy urges to defecate during MM and two actually had bowel movements after morning MM, whereas only 28% patients, mainly the younger ones, reported defecatory stimuli or abdominal discomfort and none had bowel movements during the study. The patient whose catheter was displaced because of kinking of the probe complained of cramps and pain similar to those experienced at home. The concurrent manometric recording showed frequent but disorganised MM in correspondence with the pain (Fig. 4).

### Discussion

Little is known of the pathophysiological basis of chronic idiopathic constipation.<sup>1-6</sup> The loose application of the term 'difficult defecation' irrespective of the severity of the disorder, and the lack of information on and/or uniformity in fibre intake, clinical picture, age and sex make most of the reported series difficult to compare.<sup>29</sup> We attempted to, at least partially, overcome these problems by studying a group of patients, all but one woman, who had failed to respond to laxatives or fibre intake and who presented a similar clinical picture. No patient mani-

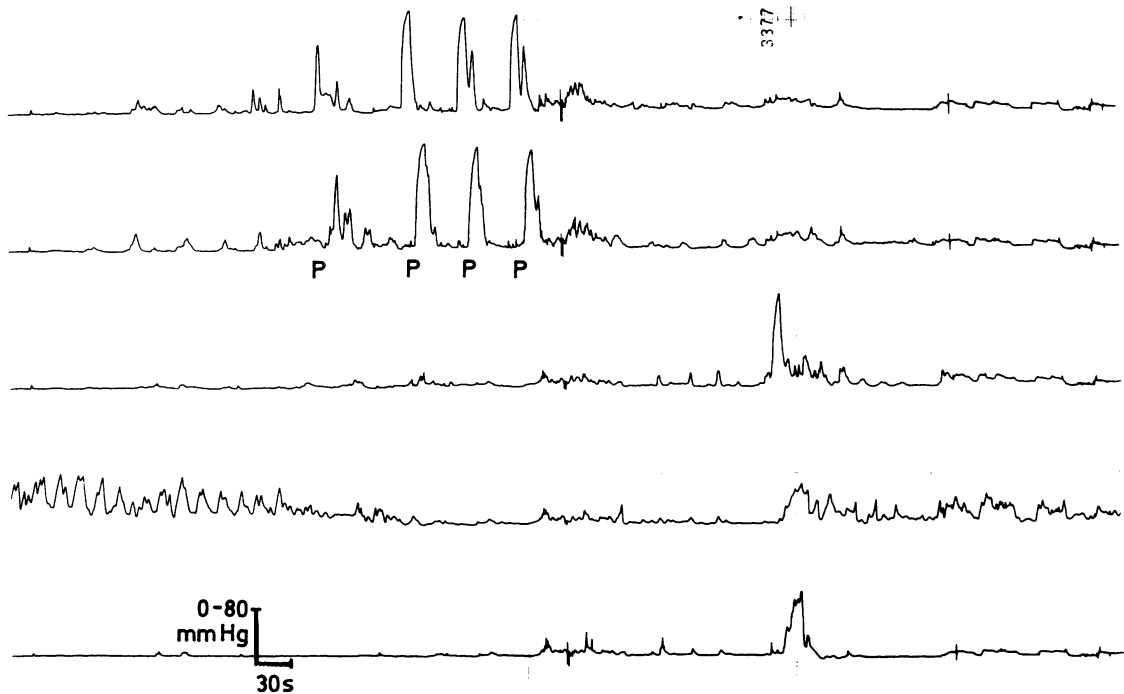


Fig. 4 Manometric recording from a constipated patient during abdominal pain due to kinking of the probe. Note the frequent but poorly propagated peristaltic sequences proximal to the kinked point (located immediately below the fifth recording point) during pain (P).

fested secondary causes of constipation and none had megacolon or megarectum which could have been responsible for an obstructive mechanism. This group of patients, would therefore, seem to have had a truly idiopathic form of chronic constipation, probably caused by colon motor dysfunction.

Although a 'soft' preparation for colonoscopy was used, it is likely that physiological conditions for recording were not present, especially in constipated subjects, and this suggests that one should be cautious when extrapolating the results.

Intestinal transit time was prolonged in 64% constipated patients, while in the remainder it was normal. This agrees with previous studies done in our country, including one on a large population sample, and showed that ITT may or may not be delayed in constipated patients.<sup>2,30</sup> The seven patients who retained markers for 168 hours (Table 2) probably had the so called 'slow transit' form of constipation<sup>2,5,31</sup> and, of these, the two whose markers were distributed throughout the large bowel are thought to have had the rare (at least in our experience) inertia colica.<sup>32,33</sup>

The 24 hour manometric recordings revealed not only that chronically constipated patients had a significantly lower mean number MM/subject, but that about 30% of them had no MM at all. Three of the four patients with no MM had prolonged ITT and two of these the clinical and radiological features of inertia colica (Table 2). As the most vigorous colonic propulsive activity able to shift colon contents over a considerable length of the large bowel is thought to be the MM,<sup>8,15-17,34-36</sup> a significant reduction in their number in certain chronically constipated patients, especially those with inertia colica, may represent an important pathophysiological mechanism.

The fact that patients' MM had an amplitude and velocity similar to controls, but a significantly shorter duration leads us to hypothesise that colonic propulsive activity is defective in some severely constipated patients.

Distribution of MM followed a circadian rhythm in patients and controls, as previously shown for healthy subjects,<sup>13,18</sup> and were significantly greater between 6 am and 2 pm than between 4 pm and 4 am (Fig. 3). The large bowel also, therefore, displays circadian variations in its motor activity, such as reported in the upper gut.<sup>17,36</sup> As the decrease in colonic propulsive activity during the night and the steep increase after meals and, especially, on awakening in the morning were documented in patients and controls, it would seem that circadian rhythms remain unaltered in chronically constipated patients.

The reduction in, or lack of, subjective feelings of defecation or abdominal discomfort during MM in

constipated patients raises the question of abdominal pain, a subject about which we have scant knowledge, even in such extensively investigated disorders as the irritable bowel syndrome.<sup>39</sup> Perhaps, the recent demonstration of colon myoenteric plexus abnormalities in severe idiopathic constipation<sup>40</sup> may lead to an answer to this question in the near future.

In conclusion, the present study on colon MM activity throughout the entire large bowel shows that, with respect to controls, chronically constipated patients have fewer and briefer peristaltic activities, as well as reduced defecating stimuli during MM. It is hoped that these findings may contribute to a better understanding of the pathophysiological mechanisms involved in this and other colon motor dysfunctions.

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