Gut, 1968, **9**, 512-520

Study of large bowel peristalsis

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Spontaneous colonic peristalsis in man occurs infrequently and, therefore, has proved difficult to investigate; radiological studies have been limited because of the dangers of irradiation, and observations of intraluminal pressure change have been mainly confined to the rectum and lower sigmoid colon (Connell, 1961; Ritchie, Ardran, and Truelove, 1962).

Progressive waves of contraction which empty long segments of colon can, however, be stimulated by an enema; such activity is usually called a stripping wave and can be regarded as a form of induced peristalsis[1] (Williams, 1967).

In the present study, both spontaneous and induced peristalsis of the colon have been studied by balloon kymography and comparisons have been made with rectal activity. (Whenever possible, cineradiology has been used to confirm the findings obtained with balloon kymography.) The study was conducted in two parts.

PART I COLONIC STUDIES

Spontaneous and stimulated peristalsis has been investigated in patients with well established colostomies, access being thereby gained to the right and left colon. Bisacodyl and Oxyphenisatin, drugs which are known to increase the frequency of stripping waves (Schlegel, 1954; McLaren, King, and Copland, 1955, and Williams, 1967), were used to stimulate colonic emptying. After establishing that the stripping waves excited by these drugs were peristaltic in nature and similar to those occurring naturally, Bisacodyl was used to induce peristalsis, so that further studies could be made of the underlying mechanism. The results of these investigations are reported.

PART II RECTAL STUDIES

Spontaneous rectal activity and the responses to Bisacodyl and Oxyphenisatin were investigated. The results are compared with those observed in the colon.

METHOD Intraluminal pressures within the colon and rectum have been recorded, using small air-filled latex balloons (5 mm × 8 mm), placed 5 cm apart, connected by fine polythene tubing to transducers, and a direct writing recorder, the unit being similar to that described by Atkinson, Edwards, Honour, and Rowlands (1957). The units were introduced into the colon or rectum with a sigmoidoscope with as little distension of the bowel as possible. Access was gained to the transverse and descending colon via well established healthy colostomies, the units being placed as far from the colostomy opening as possible. After introduction of the pressure recording unit, the bowel was left undisturbed for at least 30 minutes before a study was started. The sensitivity of the recorder was adjusted so that a change of pressure of 10 cm of water was represented by a deflection of approximately 1 cm. In certain studies, the pressure changes were also monitored by water-filled open tip tubes (internal diameter 1 mm), in addition to the balloon system.

Bisacodyl was used either as suppositories (10 mg) or as a solution in ethylene glycol. Oxyphenisatin was dissolved in water.

In seven patients, colonic peristalsis was recorded by simultaneous cineradiology and pressure recording.

RESULTS

SPONTANEOUS PERISTALSIS IN COLONIC STUDIES Normal colonic activity was studied in 48 patients (Fig. 1). During these studies, peristalsis in the transverse and descending colon was observed on only four occasions (Fig. 2). The speed of conduction of the wave varied from 20 to 25 cm/minute (average 22 cm/minute). A period of decreased pressure preceding the wave was not observed.

STIMULATED PERISTALSIS IN COLONIC STUDIES Peristalsis was induced by Bisacodyl in 17 patients and by Oxyphenisatin in eight. The effect on the transverse colon of Bisacodyl is illustrated in Fig. 3 and that of Oxyphenisatin in Figure 4.

After the introduction of either Bisacodyl or Oxyphenisatin into the empty colon, peristaltic activity was usually stimulated within two or three minutes, but if the bowel was full of faeces, the response was often delayed. In the study illustrated in Fig. 4, the colon was loaded with faeces, which was expelled after an interval of six minutes by the

[1]In this study, 'peristalsis' is used as a term to describe a regular progressive wave of contraction passing down a length of bowel and causing onward movement of the bowel content.

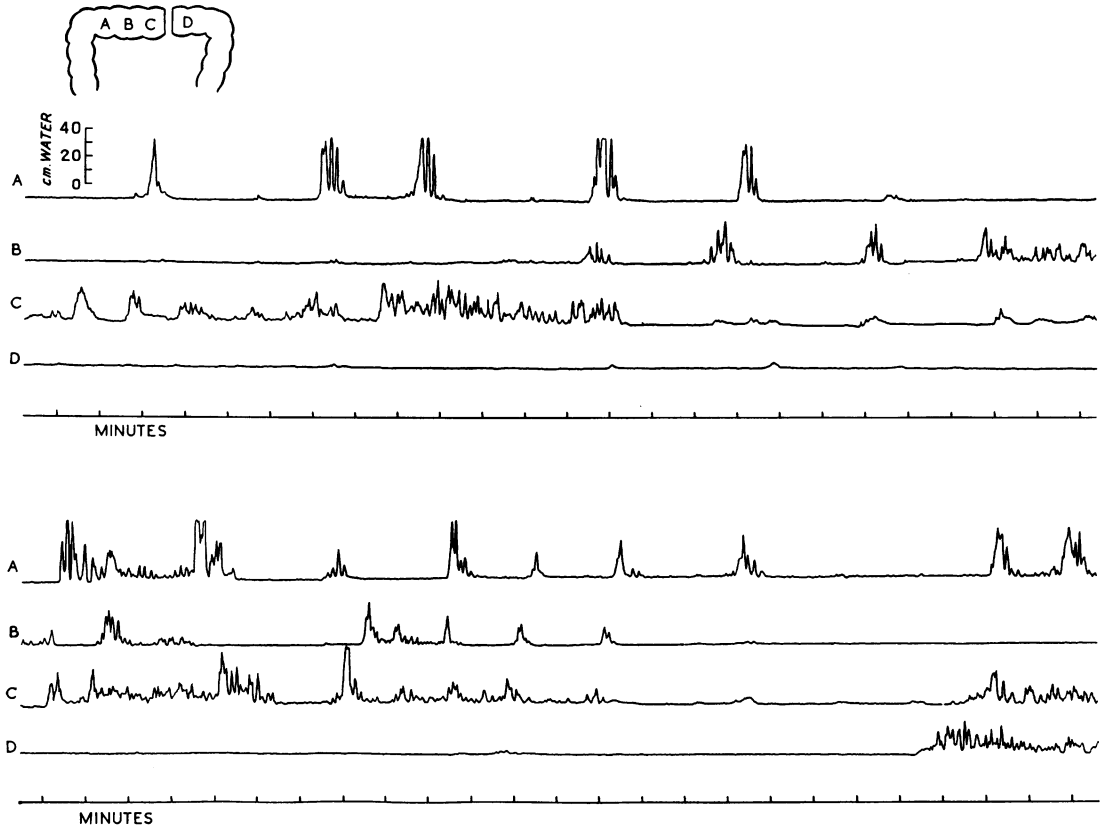


FIG. 1. *Spontaneous activity in the colon.*

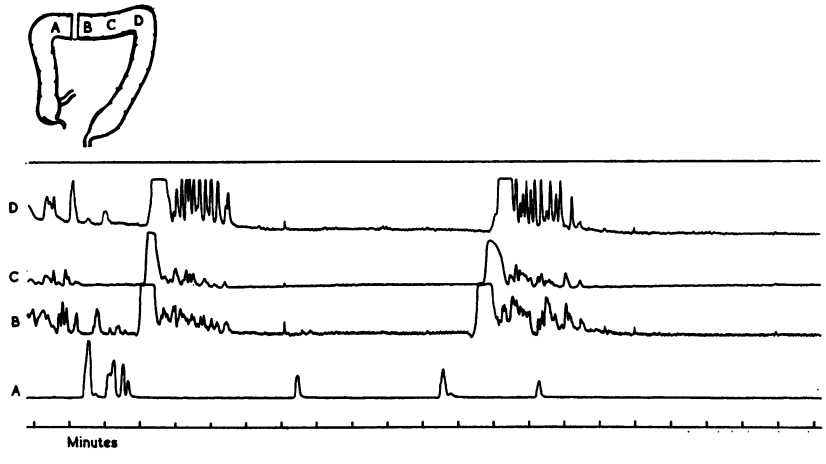


FIG. 2. *Spontaneous peristalsis in the colon.*

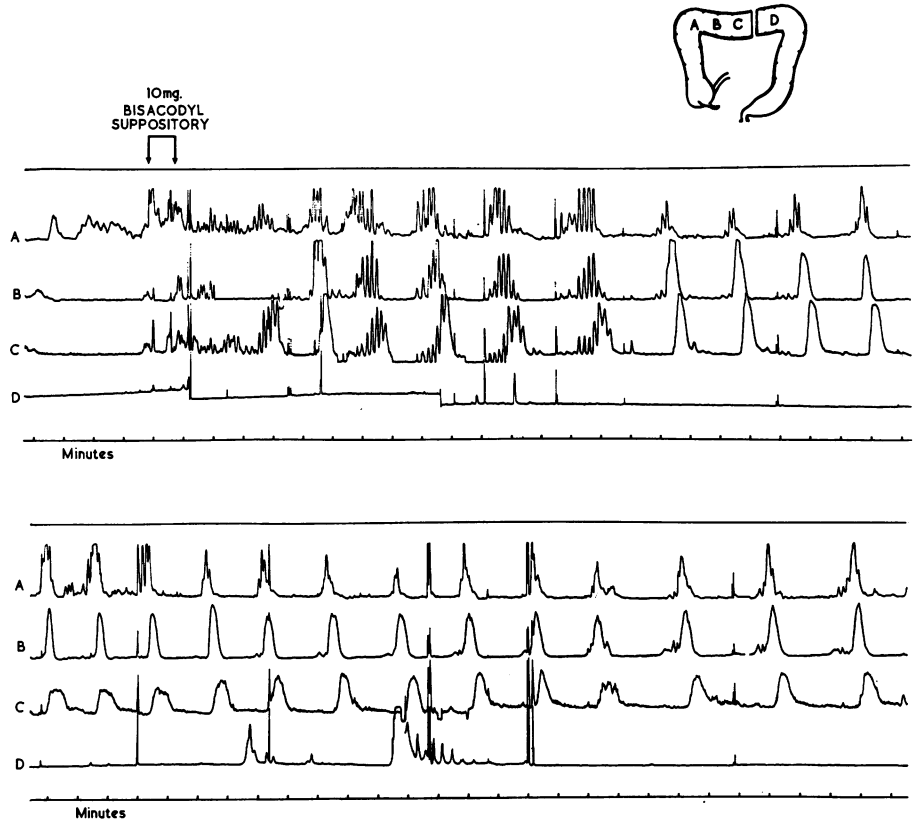


FIG. 3. *Effect of Bisacodyl on the colon.*

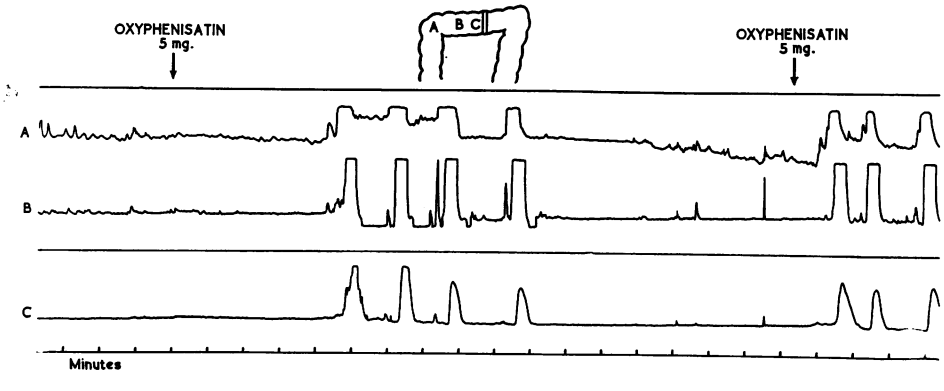


FIG. 4. *Effect of Oxyphenisatin on the colon.*

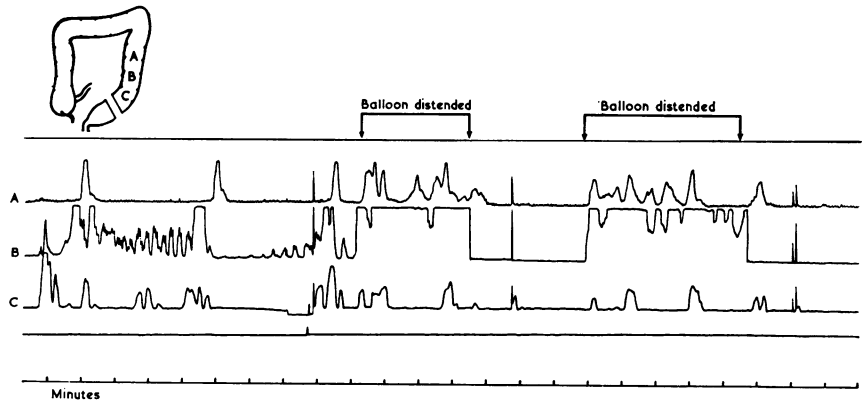


FIG. 5. *Effect of distension on the colon.*

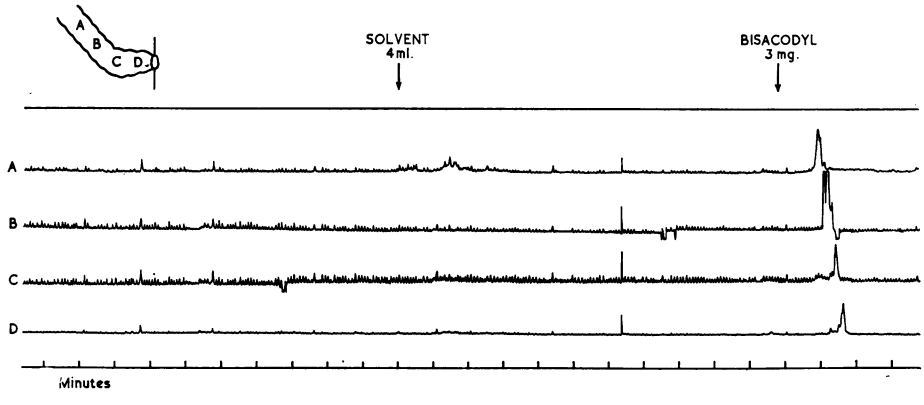


FIG. 6. *Effect of ethylene glycol on the colon.*

first waves of induced peristalsis. Subsequent applications of Oxyphenisatin resulted in the usual rapid peristaltic response.

Once peristaltic activity had been stimulated, it was usually repetitive, occurring every two to three minutes and occasionally persisting for as long as 45 minutes. The character of the peristaltic wave was similar in all regions of the transverse and descending colon and appeared to die out at the rectosigmoid junction. Healthy bowel that had been defunctioned by a colostomy responded in a similar manner to bowel containing faeces. The peristaltic wave was always directed towards the rectum and travelled the full length of the recording unit. Antiperistalsis was not observed. The average speed of conduction of the wave has been found to vary from 20 to 34 cm/minute (average 25 cm/minute).

Using both water-filled, open tip, and air-filled balloon recording units, a decrease in pressure preceding the wave of contraction has not been observed when the unit was placed in colon that was free to move.

On seven occasions, colonic peristalsis stimulated by either Bisacodyl or Oxyphenisatin was recorded by simultaneous cineradiology and pressure monitoring. It was shown on each occasion that the progressive wave of contraction recorded by the balloon unit coincided with a stripping wave which emptied the segment of colon containing the recording units.

CONTROL STUDIES IN THE COLON The effect of distension on the colon was investigated in eight patients by the use of a thin, air-filled latex balloon. Although an increase in the activity of the segment containing the balloon was usually noted (Fig. 5), peristalsis was not observed.

The Bisacodyl used in many of the studies was dissolved in ethylene glycol. When the solvent alone

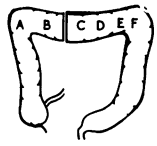
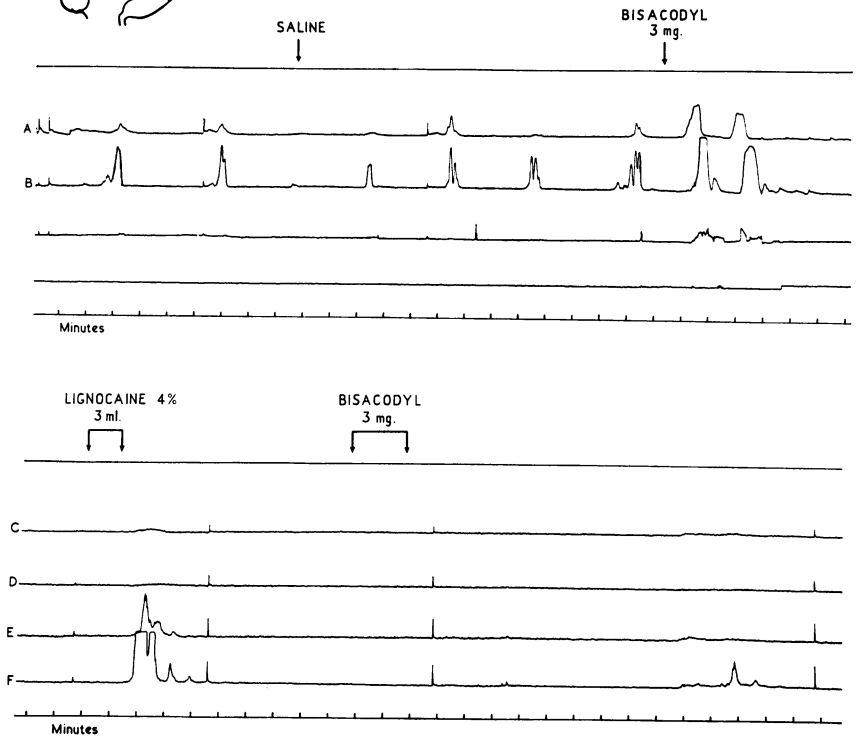


FIG. 7. *Prevention of peristalsis by prior application of Lignocaine.*



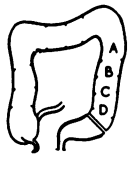
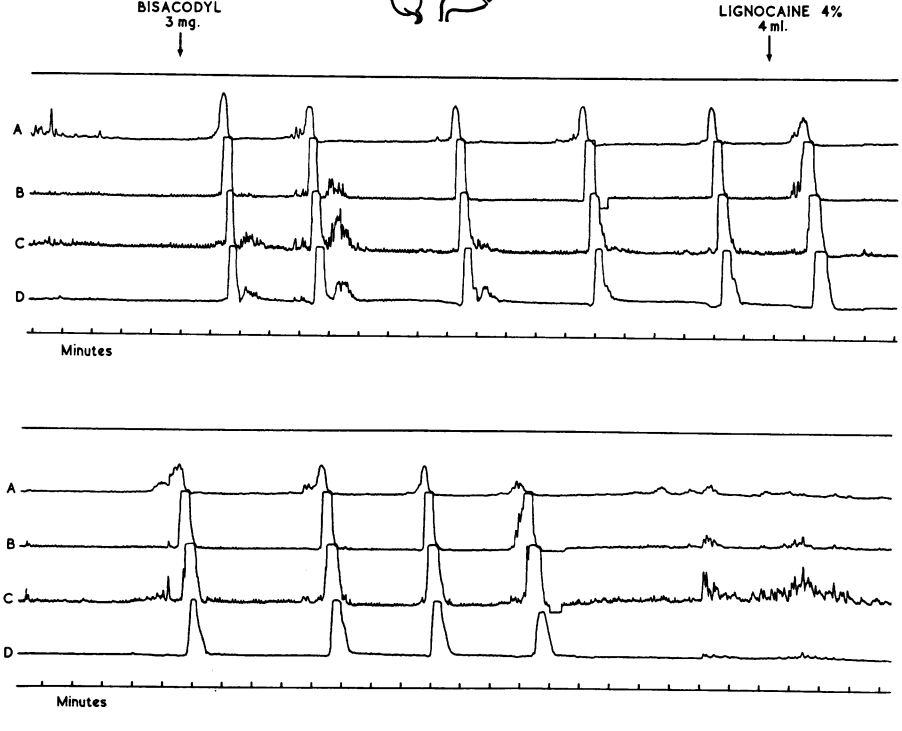


FIG. 8. *Effect of Lignocaine on established peristalsis.*



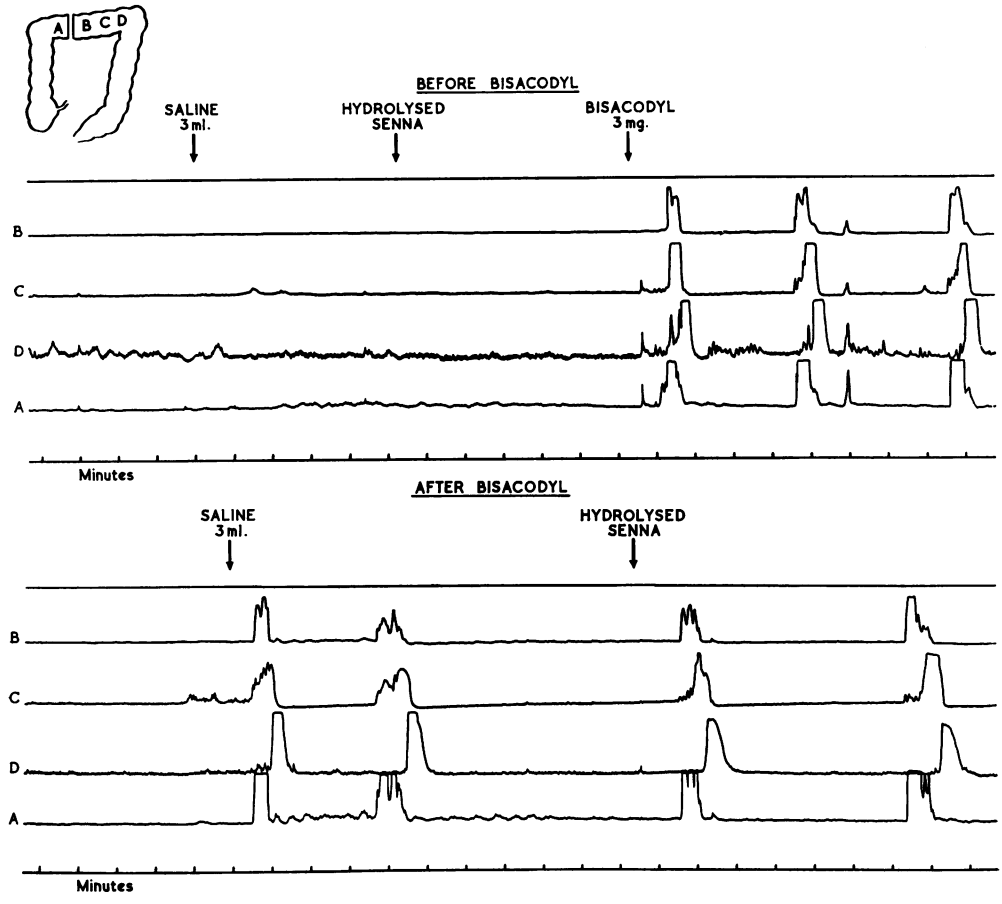


FIG. 9. *Non-specific stimulation of peristalsis.*

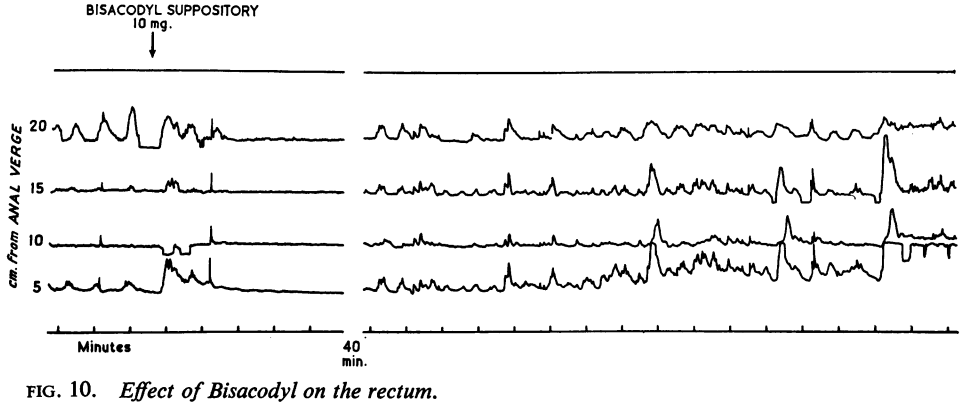


FIG. 10. *Effect of Bisacodyl on the rectum.*

was introduced into the colon (Fig. 6), peristalsis was not induced. Isotonic saline (Fig. 9) was also without effect.

ANALYSIS OF PERISTALTIC RESPONSE IN COLONIC STUDIES

INTERRUPTION OF THE WAVE AT A LOOP COLOSTOMY

Many of the studies were conducted through transverse loop colostomies, allowing simultaneous access to the right and left colon. In eight studies, when simultaneous recordings were taken from both limbs of the colostomy, it was found that peristalsis induced on the right side of the colon usually did not pass over the colostomy into the distal portion of the bowel (Fig. 3). On three occasions, peristalsis did transfer across to the distal limb, but in each case it was felt that Bisacodyl had been spilt across the intervening spur.

EFFECT OF LIGNOCAINE This was studied in six patients. The prior application of 3 ml of 4% Lignocaine to the mucosa blocked the effect of Bisacodyl. In the study illustrated in Fig. 7, the proximal side of the transverse colostomy responded in the usual fashion to Bisacodyl, the units being extruded by the second peristaltic wave. The distal section of the transverse colon previously treated with Lignocaine showed no response to Bisacodyl.

Lignocaine introduced into the colon after a peristaltic response had been established did not block the repetitive waves (Fig. 8).

NON-SPECIFIC STIMULATION OF PERISTALSIS The introduction of isotonic saline or hydrolysed senna into the colon did not cause peristalsis. If, however, these substances were introduced into the colon after a peristaltic response to previously applied Bisacodyl had recently ceased, further peristaltic waves were stimulated (Fig. 9).

It appears, therefore, that the colon can be sensitized so that previously non-specific stimuli can provoke a peristaltic response.

RECTAL STUDIES

Normal rectal activity was studied in 32 patients. The effect of Bisacodyl on the rectum in eight patients (Fig. 10) and Oxyphenisatin in six patients (Fig. 11) was observed.

An increase in motility was induced in all the subjects, and although the test was terminated by defaecation on many occasions, peristalsis was never observed. Stimulated activity was, in the main, fast low amplitude waves (type I of Templeton and Lawson, 1931). The effect of Bisacodyl on an isolated defunctioned rectum (Hartmann's operation three years before) is illustrated in Fig. 12; although activity was stimulated and was associated with a feeling of rectal fullness, peristalsis was not seen.

DISCUSSION

In this study, peristalsis has been defined as a progressive wave of contraction passing along the bowel at a regular rate, which results in the onward movement of the contents.

The wave of contraction stimulated by Bisacodyl or Oxyphenisatin has been shown to result in such movement of barium towards the rectum. The average rate of progression (25 cm/minute) was similar to that recorded radiologically (Williams, 1967).

Spontaneous colonic peristalsis, which is known to occur infrequently (Connell, 1961), was observed on four occasions, and waveform and speed of conduction were similar to those obtained with Bisacodyl or Oxyphenisatin.

The direction of all the peristaltic waves observed was towards the rectum; antiperistalsis was not seen, although there is indirect radiological evidence that this occurs naturally (Halls, 1965).

Peristalsis has often been observed to be held up at a transverse loop colostomy. This may simply be due to mechanical factors limiting movement at the colostomy. It is, however, also possible that the propagation of the wave is dependent upon continued local stimulation of the colon.

The prior application of 4% Lignocaine to the mucosa of the colon completely prevented the stimulation of peristalsis by Bisacodyl; if the Lignocaine was applied after a peristaltic response had been established, the repetitive waves of contraction were not blocked. From this evidence it seems that Bisacodyl may act by stimulation of a submucosal nerve plexus which, in turn, excites the deeper intermuscular plexus. If the submucosal plexus or mucosal nerve endings are blocked by local anaesthetic, Bisacodyl is without effect, but if the intermuscular plexus has already been sensitized, the peristaltic response continues, even if subsequently the submucosal plexus is blocked. It also appears that Bisacodyl alters the response of the colon to isotonic saline, possibly by lowering the threshold of the submucosal plexus so that the non-specific stimulus can trigger a peristaltic response.

Peristalsis has been stimulated by Bisacodyl and Oxyphenisatin thoughout the colon, but has not been observed in the rectum. The division between these two types of activity was approximately 20 cm from the anal margin. Bisacodyl affects the rectum

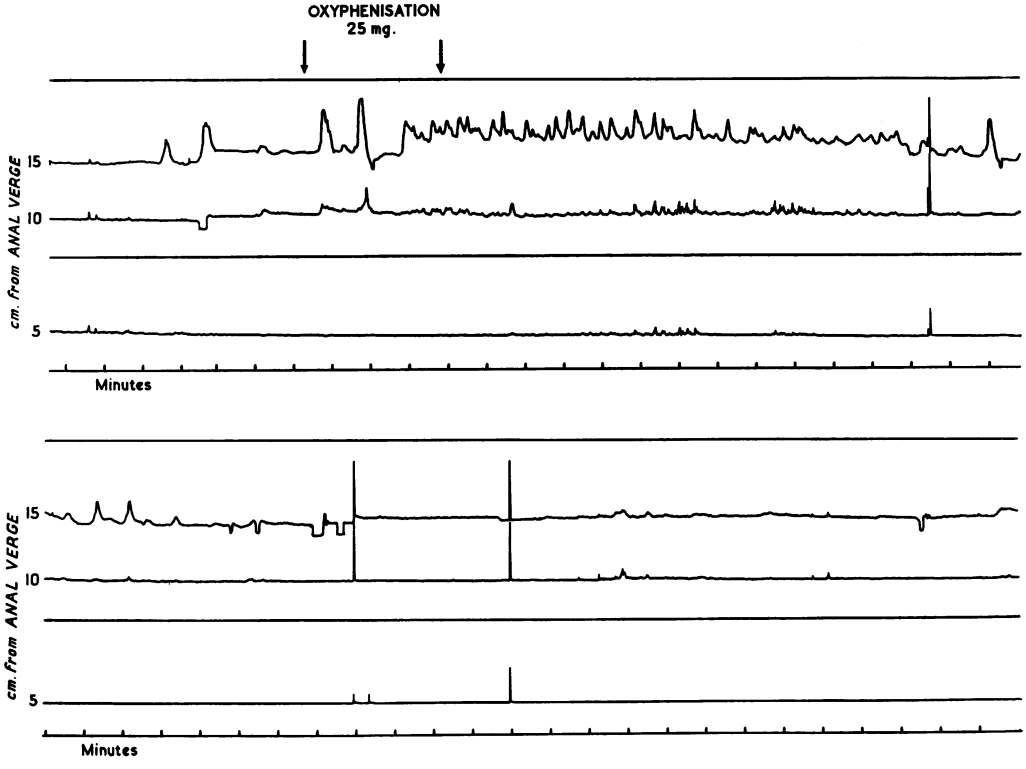


FIG. 11. *Effect of Oxyphenisatin on the rectum.*

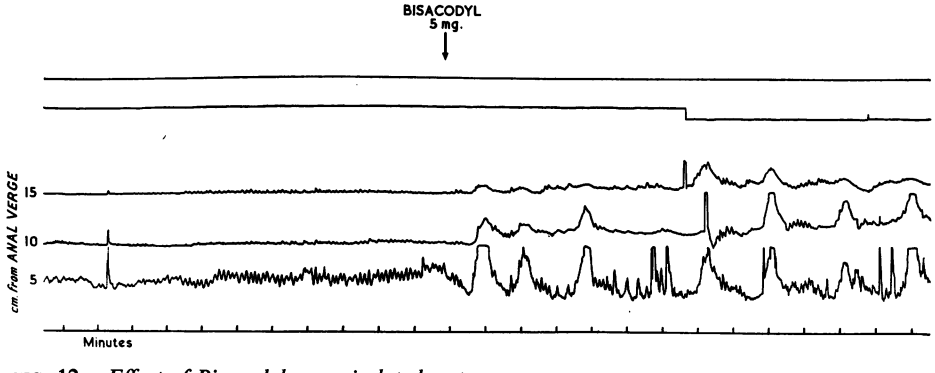


FIG. 12. *Effect of Bisacodyl on an isolated rectum.*

both by direct stimulation and also by inducing peristalsis in the lower sigmoid colon, thereby resulting in rectal filling.

SUMMARY AND CONCLUSIONS

Spontaneous large bowel peristalsis was studied by intraluminal balloon kymography and cineradiology and compared with peristalsis stimulated by Bisacodyl and Oxyphenisatin.

The following conclusions have been reached:

Spontaneous peristalsis occurred infrequently in the colon; a similar type of activity could be regularly stimulated by Bisacodyl and Oxyphenisatin.

The peristaltic wave was always directed towards the rectum, at an average speed of 25 cm/minute.

The peristaltic response was repetitive and did not pass across a loop colostomy.

Responses to Bisacodyl were blocked by prior but not subsequent application of Lignocaine.

Peristalsis could be induced in sensitized colon by non-specific stimuli.

Peristalsis did not occur in the rectum.

We should like to thank Dr R. S. Murray for his help in performing the cineradiological studies, and Boehrirnger Ingelheim Ltd, for providing a supply of Bisacodyl.

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