Basal pressure patterns and reflexive motor responses in the human ileocolonic junction

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Dinning, P. G., P. A. Bampton, M. L. Kennedy, T. Kajimoto, D. Z. Lubowski, D. J. de Carle, and I. J. Cook. Basal pressure patterns and reflexive motor responses in the human ileocolonic junction. Am. J. Physiol. 276 (Gastrointest. Liver Physiol. 39): G331–G340, 1999.—This study aimed to determine whether a sustained high-pressure zone exists at the human ileocolonic junction (ICJ) and whether the motor responses of ICJ are consistent with sphincteric function. In 10 subjects with temporary ileostomies, a high-pressure zone was identified using a manometric pull-through with a mean pressure of 9.7 ± 3.2 mmHg and length of 4.8 ± 1.2 cm. Prolonged recordings using a sleeve sensor confirmed sustained tone in the ICJ and superimposed phasic pressure waves (4–8 counts/min) occupying 35% of fasted state. A meal increased ICJ tone (P = 0.0001) and the proportion of time occupied by phasic activity to 50% (P = 0.013). Terminal ileal propagating pressure wave sequences inhibited ICJ phasic activity, and sequences not extending to the cecum reduced pressure of 9.7 ± 3.2 mmHg; length of 4.8 ± 1.2 cm. Cecal distension increased ICJ tone (8.9 ± 4.4 mmHg to 11.7 ± 4.9 mmHg; P = 0.005). The ICJ response to ileal distension was variable and dependent on resting tone at the time of distension. We conclude that the human ICJ has sustained tone with superimposed phasic activity. Tone is augmented by cecal distension or a meal and is inhibited by ileal propagating pressure waves. Response to ileal distension is variable but suggests control by descending excitatory and inhibitory pathways.

METHODS

Subjects. Ten subjects, 3 male and 7 female, with a mean age of 65 ± 15.8 yr (range 38–82 yr) were studied. All had had temporary, side-diverting, defunctioning ileostomies fashioned at least 1 mo earlier for either low anterior resections for rectal carcinoma or gracilis neosphincter procedures. The ICJ and surrounding tissue were free of disease. The ileostomies were fashioned 7–14 cm (mean 10 cm) proximal to the ICJ. All subjects had resumed normal diets when enrolled in the study. None of the subjects suffered from constipation before their operations. All gave written and informed consent. The study gained approval from the Ethics Committee of the University of New South Wales in 1994.

Manometric technique. Two catheters were used to simultaneously record pressures (Fig. 1): 1) a sleeve catheter, incorporating a manometric sleeve sensor, was inserted that projected distally from the stoma into the cecum and that recorded pressures from the cecum, ICJ, and two terminal ileal regions (side holes 5 and 6; see Data analysis); 2) a multilumen ileal catheter was inserted through the stoma that projected proximally, in an orad direction, into the distal ileum and that recorded pressures from four distal ileal regions (side holes 1–4) proximal to the stoma. The sleeve catheter was a 190-cm-long extruded silicon manometry catheter (overall OD of 4.7 mm) incorporating four lumina (ID 0.74 mm) and three side holes and a 6-cm sleeve assembly (DentSleeve, Bowden, Australia). It had a larger central lumen (ID 1.55 mm) for guide wire placement. A side hole at
the distal sleeve margin recorded cecal pressure. Two side holes, one at the proximal margin of the sleeve and a second 5 cm proximal to the upper sleeve margin, recorded terminal ileal pressures.

The ileal catheter was constructed from extruded silicon and was 150 cm long with an overall OD of 6.5 mm. It incorporated four lumina and four side holes (ID 0.58 mm) with an inter-side hole distance of 7.5 cm. A silicon balloon was built into the catheter 25.5 cm from its tip and was inflatable via a center core (ID 1.57 mm). When positioned in the proximal limb of the ileostomy (see Experimental protocol), the most proximal side hole of the ileal catheter lay 5 cm proximal to the stoma and the catheter’s silicon balloon lay 2.5 cm proximal to the stoma, thus placing the balloon 17 cm proximal to the ICJ. A separate latex balloon was attached to a polyvinyl chloride catheter (ID 1.57 mm, OD 2.08 mm), which was inserted manually into the distal limb of the stoma, and positioned 5 cm proximal to the ICJ.

Both manometric catheters were perfused at 0.15 ml/min with degassed water by a low-compliance perfusion system and were connected to external pressure transducers (Adult ICU Transpac, Abbott Critical Care Systems). Signals from the manometric recordings were amplified and digitized (10 Hz) by preamplifiers (AcqKnowledge III Software, BIOPAC Systems, Santa Barbara, CA) and recorded on a Macintosh LC 630 computer (Apple, Cupertino, CA).

Experimental protocol. After subjects were fasted overnight, the catheters were positioned via the stoma at 0800 in unsedated subjects. The sleeve catheter was placed in the distal limb of the stoma. With the use of a gastroscope, a 240-cm flexible Teflon-coated guide wire (OD 0.9 mm; Cook) was positioned via the ileostomy and the tip was positioned in the ascending colon. The sleeve catheter was passed over the guide wire into the ascending colon, and the wire was then removed. Slow, continuous pull-throughs were performed by manually withdrawing the catheter across the ICJ at a rate of ~0.1 cm/s. This process was repeated twice, and the catheter was then positioned such that the sleeve straddled the ICJ; once positioned, it was firmly taped to the skin adjacent to the stoma. Catheter position was checked fluoroscopically in all cases. In this position, there was no deformity in the sleeve (Fig. 2). The ileal catheter was then placed into the proximal limb of the stoma, with the aid of a gastroscope and guide wire. The location of each side hole was referenced to the midsleeve position when both catheters were fixed in position.

Recordings in the fasted state were obtained from 1000 to 1200, at which time a 980-kcal meal of liquid enteric feeding formula [Nepro (protein 6.4%, fat 8.8%, carbohydrate 19.8%); Ross Laboratories] was given. Postprandial recordings extended for a further 2 h from 1200 to 1400.

Two hours after the meal (1400), the ICJ responses to ileal and cecal distension were assessed. The effect of cecal distension on ICJ pressure was examined in five patients with a total of 16 rapid insufflations of 30 ml of air through the center core of the sleeve catheter. Insufflations were repeated three times with 2 min between inflations. Ileal balloon inflations were performed on 66 occasions via the proximal limb of the stoma at a site 17 cm proximal to the ICJ in nine subjects with 2, 2.5, and 3 cm balloon diameters. Balloon inflations of the distal limb of the stoma, at a site 5 cm proximal to the ICJ, were performed on 46 occasions in eight subjects with 2, 2.5, and 3 cm balloon diameters. Balloons were inflated for 60 s in both the proximal and distal ileal limbs, with a 2-min interval between inflations. Finally the catheters were removed 4–7 h after commencement of study.

Data analysis. The length and pressure of the high-pressure zone in the ICJ were determined by slow continuous pull-throughs. The distal extent of the high-pressure zone was defined as the site at which side hole pressure first exceeded cecal pressure by 2 mmHg. The proximal extent of the high-pressure zone was defined as the site at which pressure returned to within 2 mmHg of ileal pressure. For each pull-through, the length of the high-pressure zone was defined as the distance between these two sites. To calculate the pressure within this zone, we averaged the pressure recorded at each side hole at 1-cm intervals along the ICJ between the proximal and distal extents.
The influence of feeding on ICJ pressure was evaluated by measuring changes in basal tone and the total area under the pressure curve (AUC). All subsequent ICJ pressures during the fasted and fed states were referenced to cecal baseline pressure, which was defined as the minimum end-expiratory cecal pressure during the 6-h recording period. First, ICJ pressure waves were subtracted from the cecal baseline pressure. Then, each 2-h segment of tracing before and after the onset of the meal was divided into 120 1-min intervals, and the nadir pressure in each 1-min epoch was calculated. These nadir values were then averaged over the eight 15-min epochs before and the eight 15-min epochs after the meal. The AUC was also calculated for the eight 15-min epochs before and after the meal. Each 15-min epoch after a meal was compared with the mean premeal data for both AUC and tone.

The number, duration, and amplitude of ICJ pressure waves in the hour before and after the meal were calculated. Phasic activity was defined as repetitive if three or more pressure waves were observed, each having a peak-to-trough amplitude >5 mmHg, and if the frequency of the pressure waves was 4–8 counts/min (cpm) (26) but differed from that of respiratory oscillations. The duration of individual waves was totaled to determine the percentage of time occupied by ICJ phasic activity in the hour before and after the meal.

Propagating pressure waves in the distal ileum were examined. If a pressure elevation was predominately monophasic and the peak-to-trough amplitude was >5 mmHg, this was defined as a candidate pressure wave. Candidate pressure waves were then inspected with reference to pressure elevations in adjacent recording channels. If there was a sequence of candidate pressure waves recorded in at least three adjacent recording sites, with conduction velocity ranging from 0.2 to 12 cm/s, this was defined as an ileal propagating sequence, and the pressure waves within the sequence were termed propagating pressure waves. The amplitude, duration, and velocity of each propagating pressure wave within each ileal propagating sequence were measured, and these variables were then averaged for each of the two regions on either side of the stoma, yielding mean values for ileal side holes 1–4 and ileal side holes 5 and 6.

The effect of cecal air insufflation on ICJ tone was determined by comparing pressure during the 30 s before distension to that during the 30 s after distension. Each 30-s period was divided into three 10-s epochs, and the nadir pressure in each epoch (excluding artifact) was recorded. An average of the three nadir pressures before distension was compared with the averaged three nadir pressures after distension. The AUC during the 30-s epoch before distension was compared with the 30-s epoch after distension.

The effects of ileal stimulation on the ICJ tone was assessed in a similar manner. Each 1-min segment during balloon inflation was divided into three 20-s epochs, and the nadir pressure in each epoch was recorded. An average of the three nadir pressures was then compared with the average of the three nadir pressures recorded in the 1 min (3 × 20 epochs) after balloon inflation. The AUC calculated for each epoch was also compared before and after each balloon inflation. Inhibition of basal tone in the ICJ during balloon inflations or air insufflation was defined as a reduction in pressure of >2 mmHg. Similarly, augmentation of basal tone was defined as a rise in ICJ tone of >2 mmHg. In the 1 min preceding both air insufflation and balloon distension, subjects were asked not to move, thus removing the chance of artifact from movement. Any artifact that was found while measuring AUC in the pre- and postmeal epochs was not included in the calculations. Each epoch consisted of a total of 1 min of trace without artifact.

Although assessment of flow was not a primary aim in this study, episodic burst of flow of chyme was observed to emanate from the stoma. These episodes were recorded in the final four subjects by event markers on the manometric tracing for subsequent correlation with various ileal and ICJ motor patterns.

Statistical analysis. A paired t-test (two-tailed) was used to make statistical inferences regarding changes in ICJ tone and AUC between fasting and postprandial states. A paired t-test (two-tailed) was also used to make statistical inferences regarding the effects of cecal and ileal distension on ICJ tone and activity. A nonparametric (Mann-Whitney μ) test was used to determine any significant differences between wave amplitudes and duration in terminal ileum regions for propagating sequences that crossed the ICJ and those that did not. A standard error of difference between percentages (35) was used to determine any statistical inferences among the proportion of inhibitory and excitatory responses ascribed to ileal inflations of varying balloon diameters.

RESULTS

Basal recordings. A region of sustained tone was identified at the ICJ using the pull-through technique. As the catheter side hole moved from the cecum to the terminal ileum, a step-up in pressure was observed in all cases (Fig. 3). The mean length of this high-pressure zone was 4.8 ± 1.2 cm, and the mean pressure within the zone was 9.7 ± 3.2 mmHg (range 8–14 mmHg).

Prolonged sleep recordings confirmed a tonic pressure zone that was sustained throughout the 2-h fasting period with a mean pressure of 9.1 ± 0.6 mmHg (range 4–14 mmHg). Intervals of superimposed, repetitive, phasic pressure waves with a frequency of 4–8 cpm were detected by the sleeve sensor from the ICJ (Fig. 4). This phasic activity was not detected by the cecal side hole but was periodically detected by the most distal ileal recording (Fig. 5). Overall, this repetitive phasic pressure wave activity was present for 35 ± 19% of fasted recording time, and the duration of each episode of phasic activity ranged from 1.1 min to 1.5 h (Fig. 4).

A total of 18 distal ileal propagating pressure wave sequences were observed in 5 of 10 subjects (mean of 0.9/h; range 0.25–1.5/h). Eight of these occurred in the fasted state, and 10 occurred within 2 h after the commencement of the meal. Thirteen of the 18 ileal propagating pressure wave sequences extended to the cecum, whereas the remaining 5 did not. Ileal propagating pressure wave sequences had a prominent inhibitory influence on phasic and tonic activity within the ICJ. All five ileal propagating sequences that did not extend to the cecum originated when ICJ phasic activity was present and invariably inhibited ICJ phasic pressure waves and significantly reduced ICJ tone (from 9.0 ± 7.2 to 5.6 ± 6.3 mmHg; P = 0.04) (Fig. 5). All ileal propagating pressure wave sequences that extended through the ICJ to the cecum did so when phasic activity within the ICJ was absent. These propagating sequences had a significantly higher pressure wave amplitude in side holes 1–4 (68.0 ± 18.3 mmHg; P = 0.005) and had a greater pressure wave duration in side holes 1–4 (13.0 ± 8.0 s) than propagating sequences that did not extend to the cecum (amplitude 46.8 ± 12.0...
mmHg and duration of 7.6 ± 2.6 s in side holes 1–4). The extended propagating sequences contained pressure waves with a duration of 37.1 ± 10.1 s in side holes 5 and 6 and 52.8 ± 17.3 s in the ICJ. All of this exceeded the intrinsic slow wave frequency of these regions.

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<tr>
<th>Sidehole No. (Distance from ICJ)</th>
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<td>SH 1 (41.5 cm)</td>
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Meal response. In response to the test meal, there was an almost immediate increase in both ICJ tone and phasic pressure wave activity that was sustained for up to 90 min (Fig. 6). From Fig. 7, it can be seen that the increase in tone peaked at a mean of 11.8 ± 2.1 mmHg during the 15- to 30-min postprandial epoch, which was significantly higher than the mean fasting tone (9.1 ± 0.6 mmHg; P = 0.0003). During the 105- to 120-min postprandial epoch, mean ICJ tone dropped to 4.9 ± 3.0 mmHg, 46% lower (P = 0.0001) than the fasting value (Fig. 7).

Compared with the fasting state, the timing of the increase in AUC followed a pattern similar to that shown by the meal-induced increase in tone (Fig. 7). The changes in AUC were due predominantly to a significant 15% increase in the proportion of time occupied by phasic activity (35.2 ± 19.4% compared with 50.7 ± 22.5%; P = 0.013), with only minor contributions from increases in mean phasic wave amplitude (41.5 ± 19.4 compared with 49.2 ± 20.9 mmHg; not significant) and mean phasic wave duration (8.5 ± 3.6 compared with 9.1 ± 3.7 s).

Stomal flow. Twenty episodes of flow through the stoma were observed in the four subjects that had accurate correlations made between stomal flow and motor patterns. Three of the 20 episodes of stomal flow were temporally associated with ileal propagating pressure waves sequences; the remaining 17 episodes occurred in the absence of any discernible change in ileal pressure pattern. There were 4 episodes of stomal flow before the meal and 16 episodes in the two postprandial hours, 11 of which occurred between 60 and 120 min after meal onset.

ICJ responses to ileal and cecal distension. Rapid air insufflation of the cecum caused a significant and immediate increase in ICJ tone, from 8.9 ± 4.4 to 11.7 ± 4.9 mmHg (P = 0.005) (Fig. 8). Although there appeared to be a concurrent increase in amplitude of
ICJ phasic pressure waves, this could not be confirmed because a nonsignificant acute increase in AUC followed each inflation ($P = 0.08$). Phasic pressure wave frequency was unaltered by cecal distension. In one subject, cecal distension was immediately followed by an ileal propagating pressure wave sequence that propagated through the ICJ into the cecum. Interestingly, ileal tonic pressure, both proximal and distal to the ileostomy, increased steadily with sequential cecal insufflations. This was not associated with obvious gas venting through the stoma and suggests that the changes in ileal tone are not passive but probably are an active response to cecal distension. The changes in ICJ tonic pressure were clearly greater than the tonic pressure changes observed in adjacent segments of gut.

The ICJ responses to balloon distension of the ileum were variable, and the nature of responses was dependent on the distance of the distending stimulus from the ICJ and on the tone present in the ICJ at the time of distension. Balloon distensions 5 cm proximal to the ICJ induced augmentation of tone in 28–60% of distensions and an inhibitory response followed 22–40% of distensions. No response was discernible following 0–33% of distensions 5 cm proximal to the ICJ. Ileal distension 17 cm proximal to the ICJ had no effect in the majority (50–70%) of balloon inflations; however, clear-cut inhibition of ICJ tone was seen in response to 43% of distensions by a 2 cm balloon. The major determinant of the nature of the response by the ICJ was its resting tone at the time of inflation. Because balloon distension studies were conducted 2 h after the meal, 70% of balloon inflations occurred at a time when tone had declined to levels below the fasting mean. If resting ICJ tone was $\leq 10$ mmHg, particularly if the stimulus site was close to the ICJ, augmentation of ICJ tone was the likely response (mean increase from 6.5 $\pm$ 2.5 to 14.4 $\pm$ 19.5 mmHg; $P = 0.02$). However, if resting ICJ tone was $> 10$ mmHg, inhibition of ICJ tone was the most frequently observed response, with a decline in mean pressure from $17.4 \pm 5.7$ to $13.9 \pm 6.8$ mmHg ($P = 0.01$) (Fig. 9).

At times the phasic activity was inhibited during ileal distension, but at no time did ileal distension increase phasic activity.
DISCUSSION

This study demonstrated a discrete region of sustained tone at the ICJ in the human. This was demonstrated first by a pull-through technique and subsequently by prolonged recordings using a manometric sleeve assembly, the position of which was accurately maintained across the ICJ. As reported previously by others, phasic activity is prominent in the ICJ. Similar phasic activity to that seen in the ICJ was periodically seen in the side hole at the proximal margin of the sleeve (Fig. 5). Hence, the possibility exists that the high-pressure zone may extend a short distance into the terminal ileum. Ileal propagating pressure waves invariably inhibited this phasic activity when present. ICJ tone was consistently augmented in response to colonic distension. ICJ responses to ileal distension were variable, showing either inhibition or augmentation depending on the level of ICJ tone at the time of the stimulus. Our findings are consistent with the hypothesis that the ICJ has sphincterlike properties and that the junctional high-pressure zone is controlled by excitatory and inhibitory neural reflexes.

In contrast to the inconsistent findings among the manometric studies of the human ICJ, similar studies conducted in several animal species have been able to demonstrate sustained tone within the ICJ (15, 16, 27–29, 31). In these animal studies, a consistent reflexive augmentation of ICJ pressure has been reported in response to cecal distension and a somewhat less consistent, but generally inhibitory, response to ileal distension exists (17, 20, 27, 31, 32).

The ICJ is a relatively inaccessible region to study. Early attempts accessed it through various stomas, but these were limited by the poor fidelity of balloon recording catheters (6, 36). Subsequent studies with perfused catheters, in which the ICJ was accessed via a stoma and the position was confirmed radiographically, were able to demonstrate a discrete region of elevated pressure.
pressure using a pull-through technique (5, 8). A similar technique applied by Nasmyth and Williams (23) resulted in “modest” elevations in basal tone, in association with phasic activity, that were present in 63% of stations but no discrete zone of persistent tonic or phasic activity was observed in any of the pull-throughs. These authors (23) did, however, report an abrupt increase in phasic activity in 82% of pull-throughs that was associated with a significant mean step-up in basal pressure from a cecal pressure of 6.4 cmH2O. Quigley et al. (26) achieved the first prolonged recordings from the ICJ using a nasoenteric intubation technique and noted that tonic pressures across the ICJ were only evident during episodes of phasic pressure waves. Corazziari et al. (10), using retrograde perendoscopic intubation, did not identify a region of sustained tone at the human ICJ.

In the present study, we demonstrated the presence of a discrete high-pressure zone by a pull-through technique and were able to confirm that the tone was sustained by recording from the ICJ with a manometric sleeve sensor for a prolonged period. Our findings are at variance with some previous prolonged manometric studies in the human, all of which used perfused side holes (23, 26). Quigley et al. (26) utilized a nasoenteric approach to the ICJ that did not permit pull-through measurements. From our own studies with nasoenteric intubation (12), substantial relative motion between discrete recording sites and the ICJ is evident; we also found that this technique does not readily permit minor adjustments in the positions to maintain recording sites within the ICJ zone at all times. Nasmyth and Williams (23) found a significant step-up from cecal pressure on pull-through but did not demonstrate a persistent high-pressure zone. However, their 8- and 6-cm inter-side hole distances between the three side holes would have made it difficult to guarantee the maintenance of a discrete recording site within a mobile sphincter zone (23). To overcome the problem of sphincter mobility, we utilized a 6-cm sleeve assembly, which may explain in part our discrepant results.

Using a perendoscopic technique, Corazziari et al. (10) found little evidence of a sphincter zone at the ICJ. However, their technique involved placing a three-lumen catheter through the ICJ at colonoscopy and recording pressures in a stepwise fashion at each station for 4–6 min. Given that phasic activity occupied 35 ± 19% of the time in our study and the study by Corazziari et al. (10) reported that phasic activity occupied only 10% of the recording time, it is quite possible that the relatively brief recording time may not have been representative. Furthermore, prior colonic cleansing can reduce tone and amplitude of propagating sequences in the colon, and it is possible that the bowel preparation before colonoscopy required for that approach may have influenced ICJ motor patterns (1, 22).

In a study by Cohen et al. (8) using patients who had undergone a colonic exclusion procedure, a consistent high-pressure zone was located at the ICJ, which was of similar length to ours. However, the mean pressure in this high-pressure zone (20.3 mmHg) was double that found in our study. It is possible that the differences found between our study and the study by Cohen et al. (8) lie with the manometric assemblies. The diameters and flexibility of the manometric catheter and Levin tube used by Cohen et al. (8) are not mentioned. If either of these devices was relatively stiff and had a large diameter, it may explain the higher pressures recorded.

The silicon sleeve catheter in our study was flexible and had a relatively small diameter (4.7 mm). It could be argued that the step-up in basal pressure detected during pull-throughs is artifically due to passive resistance by the junctional zone against an angulated catheter. This is unlikely because the step-up in pressure was comparable in all of the radially oriented side holes along the catheter (Fig. 3). Passive pressure, if operative, would have yielded higher pressures in those side holes orientated toward the angle subtended by the junction of ileum and cecum. Furthermore, such a phenomenon could not explain the persistent tone recorded by the sleeve sensor, which was clearly shown not to be deformed as it straddled the ICJ (Fig. 2), and could not explain the phenomenon of ileal distension-induced inhibition of ICJ pressure in the absence of phasic activity.

Notwithstanding the variability among measurements of tone, all these previous studies in the human
Fig. 8. ICJ response to a rapid air inflation of the cecum with 30 ml air. Note the prominent phasic activity in the ICJ throughout. Air insufflation causes an immediate increase in ICJ tone. Note that with successive cecal air inflations both ICJ and terminal ileal tone increase, indicating that both the junctional region and distal ileum are involved in this reflex response. All distances are referenced to the midsleeve.

Fig. 9. ICJ responses to balloon distension of the ileum were variable. Major determinant of the nature of the response by the ICJ was its resting tone at the time of inflation. If resting ICJ tone was <10 mmHg (A), particularly when the stimulus site was 5 cm proximal to the ICJ, augmentation of ICJ tone was the likely response. When resting ICJ tone was >10 mmHg (B), inhibition of ICJ tone was the most frequently observed response.
and the present study concur that the ICJ does display prominent phasic activity, which is not seen immediately adjacent to the ICJ (10, 23, 26), and that this phasic activity is an important contributor to tone within the ICJ (26, 27). We also confirm the previous findings of distal ileal propagating pressure waves and migratory rhythmic phasic pressure waves, with both patterns periodically extending through the ICJ into the cecum (2, 18, 21, 26). Quigley et al. (27) also noted a transient inhibition of ICJ tone after prolonged propagating pressure waves had crossed the canine ICJ. Our observation that ileal propagating pressure waves invariably inhibit ICJ phasic activity is consistent with the notion that the phasic activity might retard or prevent flow across the ICJ and that inhibition of it, in concert with propagating ileal pressure waves, might be a prerequisite for ileocolonic flow.

Both tonic and the 4- to 8-cpm phasic ICJ pressure increased, at times virtually immediately, in response to a meal. The response persisted for 60–90 min before it returned to levels of activity below that recorded in the fasting state. Coffin et al. (7) also observed this late decline in activity, commenting that tone was at its lowest point of the entire recording 120 min after the meal. Consistent with previous reports (11, 19, 30, 33), we observed a marked increase in episodes of flow from the stoma in the postprandial period. The majority of these episodes occurred in the second hour after the meal.

Cecal distension by rapid air insufflation immediately augmented ICJ tone. This is consistent with previous findings of others in which this response was tested in the canine (14, 17, 20, 27), feline (32), and human ICJ (8, 23). This reflex is most likely mediated by an excitatory neural pathway, which in the cat at least probably involves an extrinsic spinal pathway (32). This reflex would be expected to protect the ileum from colonic reflux.

The ICJ responses to balloon distension of the ileum were quite variable. Both inhibitory and excitatory responses were observed, the nature of the response being dependent mainly on the tone present in the ICJ at the time of distension and to a lesser extent on the distance of the distending stimulus from the ICJ. If resting ICJ tone was <10 mmHg, particularly if the stimulus site was close to the ICJ, augmentation of ICJ tone was the likely response. Because balloon distension studies were conducted 2 h after the meal, 70% of balloon inflations occurred at a time when tone had declined to levels below the fasting mean. It is possible that a greater proportion of responses might have been inhibitory had the distensions been conducted in the fasted state. Studies of the canine ICJ have demonstrated both excitatory (27) and inhibitory (17) responses to ileal distension. Mixed but predominantly inhibitory responses to ileal distension have been reported in the human ICJ (8, 23). All investigators agreed that the response is confined to the ICJ. These and our findings suggest that there are descending excitatory and inhibitory pathways, both of which are activated by ileal distension. The resulting ICJ response will depend on the relative predominance of each pathway under prevailing conditions. The existence of responses to distension proximal to the stoma suggests that some of these pathways are at least 17 cm in length and are not interrupted by the ileostomy.

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