Small intestine and colon motility

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Abstract

Motor abnormalities of the small and large intestine are common in both functional and organic gastrointestinal disorders. However, the presence of some of these patterns of dysmotility in healthy controls, the absence of correlation with symptoms, and the poor response to treatments has raised questions as to whether these are epiphenomena rather than pathophysiologically relevant events. This is especially the case in functional disorders, such as irritable bowel syndrome and slow-transit constipation, where disturbances of sensitivity and autonomic nerve activity are also important. In motility disorders with an organic basis, such as chronic intestinal pseudo-obstruction and Hirschsprung's disease, the presence of predictable abnormalities of colonic and small bowel motility has helped define the condition. Radiological proof of dilated small bowel remains the diagnostic gold standard of these conditions but serial MRI techniques are proving increasingly useful in the diagnosis and measurement of small bowel motility. The advent of prokinetic drugs that target gut serotonin may lead to the specific reduction of dysmotility and the symptoms it causes. Furthermore, recognition of the interplay between motility and sensory function in functional and organic gastrointestinal disorders has suggested a therapeutic role for electrical neuromodulation of spinal and gut reflexes.

Keywords chronic intestinal pseudo-obstruction; constipation; enterokinetic; irritable bowel syndrome; manometry; motility; neuromodulation; postoperative ileus; spinal cord injury

What's new?

- Slow-transit constipation is now recognized as part of a spectrum of neuromuscular disorders of the bowel
- Measurement of global small bowel motility using novel MRI techniques is assisting the diagnosis of clinically challenging conditions
- New drug classes such as prokinetics (prucalopride) and secretagogues (linaclotide, lubiprostone) are helping to treat symptoms of constipation
- Manipulation of colonic reflexes by electrical neuromodulation offers the potential for a novel therapeutic approach in functional disorders

Abnormalities of small bowel and colonic motility are thought to underlie a variety of the most common gastrointestinal conditions, including irritable bowel syndrome (IBS), functional constipation and postoperative ileus.[1] However, the combination of difficult motility measurement techniques and multifactorial disorders has meant that the exact contribution of dysmotility to these disorders remains hard to define. Motility studies are hampered by unclear definition of objective abnormalities, poor correlation between these abnormalities and symptoms, and a wide normal range.[2] It is clear from an understanding of the physiology of the small bowel and colon (digestion and absorption of nutrients and water, propulsion of contents, storage and expulsion of faeces) that a wide spectrum of motor actions is present in health. Transit through the small intestine is rapid, typically 2–3 hours, whereas colonic transit takes 24–30 hours. This chapter will describe the physiology and measurement of small bowel and colonic motility, before considering particular conditions in which abnormal gut motility is thought to be aetiologically or therapeutically important.

Measurement of gut motility

Two classes of study are used to investigate gut motor physiology:

- Motility studies (manometric or myoelectric) assess local motility in the area where the measurement catheter is placed; they tend to be invasive and expensive.[2]
- Transit studies (usually scintigraphic or radiological) assess whole-organ motility function; they are generally less invasive and cheaper.[1]

Figure 1 illustrates the movement of tracer oleic acid from the caecum into the colon using manometric and scintigraphic studies.

Manometry studies

Manometric recording of motility is undertaken after insertion of either a perfused tube (attached to manometers) or a solid-state catheter into the selected portion of the gut. The technique is, therefore, invasive and complicated. It documents changes in intraluminal pressure induced by gut smooth muscle contraction. Small bowel manometry is undertaken by jejunal catheters inserted trans-nasally. Colonic manometry involves insertion of (usually) solid-state catheters trans-anally into the unprepared bowel at colonoscopy. Bowel preparation makes the procedure less complicated, but the preparation itself interferes with motility. Manometric studies will detect the presence of abnormal patterns of motility in whichever segment of the gut is being studied, but cannot identify discrete pathognomonic abnormalities that differentiate organic disease states (let alone functional disorders) from normal bowel. The exception to this is small bowel manometry in chronic intestinal pseudo-obstruction, in which certain patterns help differentiate a myopathic from a

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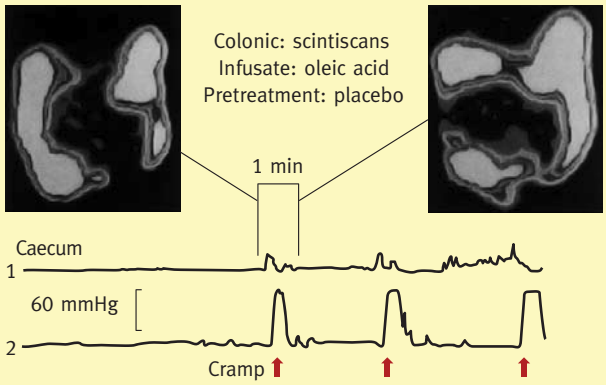
The relationship between colonic pressure and bolus movements



The relationship between colonic pressure waves and mass bolus movements is shown in this combined scintigraphic (upper panels) and manometric (lower panels) study before and 1 minute after infusion of oleic acid into the caecum. Oleic acid induces multiple high-amplitude propagating contractions in temporal association with mass movements of the tracer (as seen by distal movement of tracer between the scintigraphic panel on the left and right).
Adapted from *Gastroenterology* 1979; **77:** 1235–40.

Figure 1

neuropathic cause (see below). For this reason, manometry of the small and large bowel remains largely a research tool.

Transit studies

Small bowel transit time — or oro-caecal transit time — is readily assessed by a hydrogen breath test, which involves ingestion of a poorly absorbed sugar (such as lactulose) after a period of fasting. The principle of the test is that hydrogen is produced only by anaerobic bacterial fermentation. Assuming that the patient does not have small bowel bacterial overgrowth, fermentation can occur only in the distal ileum and colon. The hydrogen diffuses into the bloodstream and is rapidly exhaled in the breath. However, intra-patient reproducibility is poor.

Small bowel transit can also be assessed using a gamma camera to take images after ingestion of a radioisotope-labelled solid and liquid meal. This is often performed as an extension of a radioisotope gastric-emptying scan. Although more reproducible than the hydrogen breath test, this procedure involves exposure to ionizing radiation for a measurement that may have little impact on clinical management.

Endoluminal image analysis is a non-invasive approach to measuring small bowel motility using capsule endoscopy. This technique allows continuous visualization of intestinal wall motion and luminal diameter changes, thereby providing information on contractile and non-contractile activity, motion of the gut wall and luminal content. However, this is still a research tool and not widely available.

Colonic transit time is easily assessed in clinical practice by the measurement of movement of radio-opaque markers on a plain film of the abdomen taken at a fixed time after ingestion of the markers. This test is highly reproducible, and is most useful in determining whether constipation symptoms are due to slow or normal transit. Some researchers have used mathematical extrapolations of this technique to calculate a 'colonic transit time' although the validity and usefulness of this measurement have been questioned. An alternative technique to estimate colonic transit time involves a scintigraphic assessment methodology, following either oral administration or trans-anal placement of a radio-labelled bolus into the colon. However, the method is invasive, expensive and cumbersome.

The wireless motility capsule or SmartPill® measures pressure, pH and temperature in the bowel through ingestion of a wireless transmitting capsule, which communicates with a portable receiver worn by the subject; it has been studied in both healthy volunteers and patients with constipation, and its reliability has been compared with that of standard radio-isotope and marker techniques.[3,4] Small bowel and colonic transit is measured by assessing the interval between the sharp pH rise as it enters the duodenum and the further pH spike on transition into the colon. Total transit time measured by wireless capsule correlates well with scintigraphy and marker studies of transit. In addition, the system is preferred by patients and requires less manpower to administer than scintigraphy. It offers promise as a useful diagnostic test in both clinical practice and in research studies of emerging enterokinetic agents.

Physiology of gut motility

The rates of transit through the different regions of the gut are determined by the physiological mechanisms involved in gut motility.

Small bowel motility

The major physiological influences on small bowel motility are digestive status and diurnal variations. Fasting small bowel motility follows three cyclical phases, during which contractions originate in the stomach and migrate slowly downstream. These three phases of the so-called migratory motor complex (MMC) are coordinated by both central and peripheral (neural and humoral) factors (Figure 2).

- Phase I of the MMC lasts 5–20 minutes and is characterized by absence of contractions.
- Phase II lasts 10–40 minutes and consists of intermittent contractions on a background of about 50% of slow waves.
- Phase III lasts 3–6 minutes and is characterized by bursts of regular rhythmic contractions occurring at the same rate as the slow waves.

Following a meal, vigorous contractions begin in the small bowel; the amplitude and duration of this activity depends on the caloric content and nature of the meal. Although meal factors play a role, there are also important CNS mechanisms (meal anticipation, mood, state of arousal) that influence the postprandial pattern change.[5]

Colon motility

Gut physiologists classify colonic motility as either segmental activity (erratic single or clustered contractions) or propagated activity (low-amplitude propagated contractions [LAPCs] or high-amplitude propagated contractions [HAPCs]). Segmental contractions are typically in the three cycles/minute frequency,