Imaging approach to measuring small bowel motility

Michael Camilleri
Clinical Enteric Neuroscience Translational and Epidemiological Research (C.E.N.T.E.R.), Mayo Clinic, Rochester, Minnesota

Submitted 5 August 2015; accepted in final form 5 August 2015

THE ARTICLE BY CAROLINA MALAGELADA and colleagues in Barcelona entitled “Classification of functional bowel disorders by objective physiological criteria based on endoluminal image analysis” represents an important advance in the measurement of small intestinal motor functions (5). This novel approach involves novel imaging, combinations of physics and mathematics, as well as gastrointestinal physiologists and clinicians. The rationale for developing the method in the evaluation of small intestinal motor function is well articulated in the authors’ discussion: “clinical diagnostic criteria appear to have limited value in determining the underlying mechanism of the symptoms in the functional gastrointestinal disorders and, conversely, current technologies often fail to detect abnormalities in gut physiology in these patients” (5).

What Are the Available Methods to Potentially Identify Small Intestinal Motor Dysfunction?

Rarely does one encounter dilated loops of small intestine or multiple small bowel diverticulosis in clinical practice. These features suggest myopathic diseases such as scleroderma, amyloidosis, or mitochondrial cytopathy. Patients with these diseases can usually be identified by other serological, muscle enzyme, or protein studies or by genetic testing rather than requiring small intestinal manometry for diagnosis. Typically, modern cross-sectional imaging studies including ultrasonography, CT enterography, or MR enteroclysis do not identify contraction abnormalities, although differences in small bowel intestinal water content (6) and abnormalities on cine-MRI (7) have been described, predominantly in patients with chronic intestinal pseudo-obstruction.

In healthy subjects, the transit time of barium from duodenum to cecum was once reported to range from 16 to 640 min (10). Scintigraphy, documenting colonic filling at 6 h (a surrogate of overall small bowel function), ranged from 0 to 100% (although the mean was 44%) in a study of 319 healthy volunteers evaluated predominantly for estimation of gastric emptying parameters (3). Small intestinal manometry (2) reveals high variability [e.g., frequency of interdigestive migrating motor complexes from 1-20 per 24 h (12)] or low specificity [e.g., propagated clustered contractions occur in health, irritable bowel syndrome, and chronic intestinal dysmotility (4, 8)]. Malagelada et al. appropriately summarize that, “for the majority of patients, manometry does not identify distinctive features that could be used as physiological diagnostic criteria” (5). The only definitive pathological features on small bowel manometry are findings suggestive of myopathy [amplitude typically <10 mmHg (11)] when the intestinal diameter is <3.6 cm, which was demonstrated to be the sensitivity threshold for phasic contractions in human large intestine (9) or the presence of simultaneous prolonged contractions that suggest mechanical obstruction (1). The latter diagnosis is typically identified on cross-sectional imaging studies before the performance of small bowel manometry.

Novel Observations on Small Intestinal Motility Based on Image Analysis

Malagelada and colleagues (5) have used a robust sequence of validations to identify characteristics on image analysis with an endoluminal capsule. Endoluminal image analysis was performed by computer vision and machine learning techniques to define the normal range and to identify clusters of abnormal function. After training of the algorithm, a separate cohort of 196 patients and 48 healthy subjects was used as the test set. The study showed that, compared with healthy subjects, patients with hypodynamic function (n = 38) exhibited significantly less luminal closure sequences (41 ± 2% of the recording time compared with 61 ± 2% in healthy subjects) and more static sequences (38 ± 3 vs. 20 ± 2%). In contrast, patients with hyperdynamic function (n = 13) on image analysis had a significantly increased proportion of luminal closure sequences (73 ± 4 compared with 61 ± 2% in healthy subjects) and more high-motion sequences (3 ± 1 vs. 0.5 ± 0.1%). Hyperdynamic function was associated with faster small intestinal transit of the capsule, although transit was not different between those with hypodynamic function and healthy subjects.

The functional significance of these image-based assessments of small intestinal motor function is still to be determined. Abnormal motility compared with normal motility was not associated with gender, age, Rome III diagnosis, symptom scores, presence of diarrhea/constipation/pain, or duration of symptoms. The diagnostic value of these measurements requires further studies; the relationship to extrinsic autonomic dysfunction (vagotonia, vagal dysfunction, sympathetic adrenergic dysfunction) requires studies in animal models or patients with fully characterized denervation. Ultimately, pharmacological effects on the image-based dysfunctions will need to be appraised pari passu the clinical responses.

The novel findings in the study by Malagelada et al. (5) deserve further elucidation; the Herculean effort involved in establishing normal patterns of motion and algorithms of analysis should enable further studies to explore the uncharted territory of small bowel motility in health and disease states.

REFERENCES


