Small-Bowel and colon Transit

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Dyspeptic symptoms related to dysmotility originating from the small bowel or colon usually include:

Abdominal pain
Diarrhea
Constipation

However, symptoms overlap and it is difficult to differentiate whether they originate in the upper or lower gastrointestinal tract or both.
Indications:

- Dyspepsia
- Irritable bowel syndrome
- Chronic constipation
- Chronic diarrhea
- Chronic idiopathic intestinal pseudoobstruction
- Scleroderma
- Celiac disease
- Malabsorption
It is recommended that gastrointestinal transit studies be used to localize the potential site of disease and guide therapy.

A final diagnosis of a primary motility disorder by scintigraphy should not be made until an anatomic or structural cause for abnormal transit has been excluded.
Nonscintigraphic methods:

- Hydrogen breath tests for small-bowel transit
- Radioopaque markers for colon transit
- Wireless motility capsule
The American Neurogastroenterology and Motility Society:
The scintigraphic method is the only one that reliably allows the determination of both total and regional transit times for gastrointestinal and colon transit.

Although scintigraphic methods for measuring small bowel and colon transit have been in use for at least 20 y, they have not gained widespread clinical use, in large part because of their lack of standardization.
GENERAL METHODOLOGY:

99mTc

111In

67Ga

Small-bowel and colon transit scintigraphy is typically performed alone or, with minor modifications, as a continuation of a gastric emptying study.
Three methods have been reported:

1) Mixed solid-liquid gastric emptying meal with the liquid phase being radiolabeled with 111In diethylenetriaminepentaacetic acid (DTPA).

2) Delayed-release, methacrylate resin-coated capsule containing 111In-labeled activated charcoal particles.

3) 67Ga-complexes for 111In-DTPA as part of a mixed solid-liquid meal.
SMALL-BOWEL TRANSIT STUDIES

The function of the small bowel is to transport food as it empties from the stomach and to mix it with bile and with pancreatic and intestinal secretions to facilitate absorption over the bowel mucosal surface.
The ileocolonic junction between the terminal ileal reservoir and the cecum regulates the flow of intestinal chyme from the small bowel into the colon.
More recently, scintigraphy has been combined with manometric pressure recordings to measure flow across the ileocecal valve. By direct instillation of radioisotope through a nasocolonic catheter that has multiple recording sites extending from the terminal ileum to the proximal colon, discrete episodic movements of luminal flow have been recorded.
The simplest conceptual approach to scintigraphic measurement of small-bowel transit is to measure orocecal transit time by imaging the leading edge of radiotracer transit through the bowel.

Accurately defining the leading edge (the first visualized arrival of activity in the cecum), however, requires frequent (every 10–15 min) and prolonged imaging because of the stasis in the terminal ileum.
In one study: orocecal transit times were 56 \( \pm 4 \) min for lactulose breath testing and 43 \( \pm 4 \) min for simultaneously performed scintigraphy. However, lactulose itself speeds small-bowel transit and accelerates orocecal transit. Without lactulose, the scintigraphic orocecal transit time was 231 \( \pm 37 \) min.
Small-bowel orocecal transit time will vary with the meal administered. When measured using resin pellets mixed with a meal, orocecal transit time in healthy individuals ranged from 151 to 290 min. When measured using the liquid phase of a mixed solid–liquid meal, small-bowel transit time ranged from 72 to 392 min in healthy individuals.
The progressive buildup of activity in the terminal ileum can easily be measured and used as an index of small bowel motility.

The recent SNMMI/EANM guideline on small-bowel transit recommends use of the percentage of administered liquid meal that has accumulated in the terminal ileum at 6 h after meal ingestion as a simple index of small-bowel transit. Small bowel transit is considered normal if more than 40% of administered activity has progressed into the terminal ileum or passed into the cecum and ascending colon at 6 h.
Small-bowel transit is typically considered delayed if activity persists in multiple loops of small bowel at 6 h and little (<40%) to no activity arrives in the terminal ileum reservoir.
The amount of colon filling at 6 h has also been used as an index of small-bowel transit.

The range for normal filling of the colon at 6 h using nondigestible particles is 11%–70%.

The range for digestible solids is 43%–95%.
Three distinct colon contraction patterns with different spatiotemporal patterns have been described. **Rhythmic phasic contractions aided by tonic contractions** cause slow distal propulsion and mixing. **Infrequent giant migrating contractions** produce mass movements.
Poor motility causes greater absorption, and hard feces in transverse colon cause constipation.

Excess motility causes less absorption and diarrhea or loose feces.
Therapy for patients with chronic constipation depends on identifying whether there is colon inertia, generalized slow colon transit, pelvic floor dysfunction, functional outlet obstruction, or irritable bowel syndrome.

- Radiographic markers

- Wireless motility capsule
Colon transit scintigraphy is indicated for measuring transit time in patients with constipation or diarrhea and can be used as a marker to validate new treatments and to direct patient care.

- $^{111}\text{In}$-DTPA
- $^{67}\text{Ga}$-citrate
**TABLE**
Comparison of Adult Dose Estimates for Oral 111In-DTPA vs. 67Ga-Citrate

<table>
<thead>
<tr>
<th>Radiopharmaceutical</th>
<th>Dose</th>
<th>Effective dose</th>
<th>Absorbed dose in lower large intestine (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>111In-DTPA</td>
<td>4</td>
<td>1.20</td>
<td>Normal 6.4, Constipated 11.6</td>
</tr>
<tr>
<td>67Ga-citrate</td>
<td>4</td>
<td>0.74</td>
<td>Normal 6.5, Constipated 11.8</td>
</tr>
</tbody>
</table>
Two methods that use oral $^{111}$In-DTPA to measure colon transit have been most commonly applied.

One method (Mayo Clinic) requires preparation of a resin-coated capsule designed to dissolve at a pH of 7.2–7.4 in the environment of the ileum (pH 7.4).

An alternate method (Temple University), which does not require fabrication of a special capsule, is to use $^{111}$In-DTPA as part of a standard solid-liquid gastric emptying meal.
To quantitate colon transit, the geometric center has been defined as a measure of the progression of colon radiotracer activity.

To calculate the geometric center, the colon is divided into anatomic regions, each of which has a numeric value. With the solid–liquid meal method, a 7-segment analysis includes cecum–ascending colon, hepatic flexure, transverse colon, splenic flexure, descending colon, rectosigmoid colon, and excreted stool. The geometric center is a weighted average of the counts in each region.
Geometric center = \( \text{sum} \left( \frac{\text{ROI}_i}{\text{total counts}} \right) \times i \) 

\[ (i = 1-7) \]

Regions of interest in 7-segment method

- Hepatic flexure
- Ascending colon & cecum
- Transverse
- Splenic flexure
- Descending colon
- Rectosigmoid colon
- Excreted feces

(Calculated: total initial abdominal counts – amount retained)
The normal mean values for geometric center are:

- 4.6 ± 1.5 at 24 h
- 6.1 ± 1.0 at 48 h
- 6.6 ± 0.19 at 72 h

For the mixed solid–liquid meal method, colon images are acquired at **24, 48, and 72 h**.
If the geometric center at 48 h is less than 4.1 (proximal to the splenic flexure), no further imaging is needed because colon transit is delayed. 

If the geometric center is greater than 4.1 but less than 6.4, imaging should be performed at 72 h to exclude functional outlet obstruction.
There are 3 major patterns of slow colon transit:

1) Generalized slow transit with diffuse retention throughout the length of the colon

2) Marked right-sided retention proximal to the splenic flexure (colon inertia).

3) Retention in the rectosigmoid (functional rectosigmoid obstruction)
WHOLE-GUT TRANSIT STUDIES

Whole-gut transit scintigraphy refers to a combined study that includes measurement of gastric emptying, small-bowel transit, and colon transit after administration of a dual-isotope, solid-liquid meal.

Colon transit is slowed more commonly in patients with organic disease and is normal in many patients with functional complaints of constipation.
Whole-gut transit scintigraphy “is indicated to measure whole gut and regional colon transit in patients with suspected colon motility disorders or more diffuse disorders involving the stomach or small intestine”.
- Irritable bowel syndrome
- Idiopathic constipation
- Celiac disease
- Intestinal pseudoobstruction
CONCLUSION

Because of the difficulty often encountered in deciding whether a patient’s symptoms originate in the upper or lower gastrointestinal tract, gastrointestinal transit scintigraphy is a uniquely suited noninvasive, quantitative, and physiologic method of determining whether there is a motility disorder affecting the stomach, small bowel, or colon.

It is hoped that newly published standards for performing these studies.
DEAR TEACHERS, THANK YOU ALL!