SUBJECT: GASTRIC EMPTYING (Solid and Liquid)

Overview

Radionuclide studies of gastric emptying and motility are the most physiologic studies available for studying gastric motor function. The study is noninvasive, uses a physiologic meal (solids with/without liquids), and is quantitative. Serial testing can determine the effectiveness of therapy.

Indications

A. Postprandial:
   1. Nausea, vomiting
   2. Upper abdominal discomfort, bloating
   3. Chronic aspiration
B. Suspected gastroparesis
C. Poor diabetic control
D. Gastroesophageal reflux
E. Following response to therapy for previously documented motility disturbances.
F. Diagnosis of functional gastric dysmotility.

Examination Time

Variable, ranges from 2-4 hours.

Patient Preparation

1. NPO 4 hours before imaging. It is preferable to be NPO after midnight, and then administer radiolabeled meal in the morning.
2. Diabetic should be instructed to bring insulin with them. The dose of insulin is to be adjusted when meal is given. If the patient cannot tolerate standard solid or liquid meal study, the procedure should not be done.
3. Patient must be off of motility drugs including: reglan, domperidine, cisapride, or erythromycin

Equipment & Energy Windows

Gamma camera: large field of view.
Collimator:   - Medium energy for solid and liquid (In-111 DTPA)
             - VXGP or LEHR if solid only study
Energy window:
   Solid & Liquid – 10% window centered at 140 keV for Tc-99m and 171 keV for In-111.
   Solid Only - 20% window centered at 140 keV for Tc-99m
                Computer.
   Liquid Only - 20% window centered at 140 keV for Tc-99m
                Computer.

Radiopharmaceutical, Dose, & Technique of Administration

Radiopharmaceutical:

**ADULT:** Pediatric dose base on weight
Solid Study: 750 uCi Tc-99m sulfur colloid labeled egg substitute 4oz.
Liquid Study: 500 uCi Tc99m DTPA
***Dual phase Liquid Study: (300 uCi In-111 DTPA)
**INFANT:** breast milk or equivalent
Liquid(solid)Study: 100 uCi Tc99m SC
3oz formula for 0-3 months old
Patient Position & Imaging Field

Patient position:
- Adults: Standing (static images) or supine (dynamic images) (camera dependent)
- Infants: Supine (static images) mark belly button for accurate placement

Imaging field: Upper abdomen.

Food Preparation Protocol

SOLID PHASE:

Food Supplies: 4oz egg substitute, 2 pats of butter, 4oz water, two slice bread.
Pediatric: 2oz egg substitute, 1 pat of butter, 2-4oz water, one slice bread.

Heat up pan on medium heat on the hot plate in the hot lab.

A. In Styrofoam cup mix egg substitute thoroughly.
B. Add your Te into the raw egg substitute and mix a little more.
C. Use one pat of butter in heated pan. When melted, pour in the mixed egg.
D. Cook over medium heat. You can cook like an omelet or like scrambled egg.
E. Toast bread.
F. Put Tc99m DTPA in cup of water.(In-111 DTPA if dual phase)
***Water and Tc-99m DTPA only if Liquid study is indicated.
G. Serve egg, bread and water immediately.

**The meal may be eaten as a sandwich to decrease the time required for ingestion; if preferred, the eggs and toast may be eaten separately.

LIQUID PHASE:

Food Supplies: 4-6 oz. Water or juice.
For adult patients put Tc99m DTPA in the cup of water or juice.
For pediatric patients, put Tc99m S.C. in appropriate amount of formula or breast milk.

***make sure parents bring their own formula, and a disposable bottle that can be stored in decay storage.***

Acquisition Protocol

1. Tell the patient to eat the meal as quickly as possible. (Under 10 minutes preferable)
2. Note the length of time from when the patient started eating to when the images started.
3. Note how much food the patient ate. (Should eat all portions)

A Serial Static Imaging

Solid Phase:

1. Record the Position on the computer and just return the patient to the same spot each time.
2. Acquire serial 1-minute anterior and posterior digital images at 0 minutes, 30 minutes, 60 minutes, 120 minutes, and 240 minutes.
3. The patient should remain quiescent between image acquisitions because exercise decreases gastric emptying times.
4. Patient should remain NPO for the duration of exam.

B. Dynamic Imaging:

*Use this study ONLY when unable to do upright serial static images!
1. Immediately after eating have the patient lie down on the camera bed (dual-
headed camera only).
2. In the Gastric program, select the first study, which is ‘Dynamic’.
3. Begin imaging immediately.
4. This scan will run for 60 minutes at 60 sec a frame.
5. 1 minute images at 2 and 4 hours.

C. Liquid phase:

1. Place the patient in a 45 degree supine position. If patient is unable to tolerate standard positioning, the position used must be clearly noted. Patient may be seated or supine for exam.
2. Acquire serial 60 second per frame dynamic digital images for 30 minutes.

D. Pediatric imaging: Infant-6months

Acquire serial 1-minute anterior and posterior digital images at 0, 15, 30, 45, and 60 minutes, then every 30 minutes after the first hour until the activity remaining is less than 50%. This allows for a true T ½.

### Table 2
Normal Limits for Gastric Retention

<table>
<thead>
<tr>
<th>Time point</th>
<th>Lower limit (a lower value suggests abnormally rapid gastric emptying)</th>
<th>Upper limit (a greater value suggests abnormally delayed gastric emptying)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5h</td>
<td>70%</td>
<td>90%</td>
</tr>
<tr>
<td>1.0h</td>
<td>30%</td>
<td>60%</td>
</tr>
<tr>
<td>3.0h</td>
<td>30%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Data are from *Am J Gastroenterol*. 2007;102:1–11.

*Normal values for solid phase*—up to 52% retention at 2hrs, up to 10% retention at 4 hrs.

*Journal Nuclear Medicine vol.48 no.4 April 2007 pages 568-572

*Normal values for Liquid phase*—T ½ of 7 to 20min

For the 30 healthy subjects, the liquid water half-emptying time ranged from 6 to 20 min (14.3 6 4.1 min). The T1/2 exponential-fit clearance rate ranged from 7 to 19 min (12.4 6 3.1 min). *(THE JOURNAL OF NUCLEAR MEDICINE • Vol. 50 • No. 5 • May 2009 LIQUID GASTRIC EMPTYING • Ziessman et al. pg727 Harvey A. Ziessman1, Ankit Chander1, John O. Clarke2, Alison Ramos1, and Richard L.Wahl1)*

- Normal range for Tc-99m-sulfur colloid labeled instant oatmeal is up to approximately 1 hour (12). It should be remembered that gastric emptying is affected by meal composition, volume, and calorie content. As well as proportions of fat, carbohydrate and protein, gender and patient age (19-22).

***There is approximately 8% scatter from Tc-99m into the In-111 window and 23% scatter from In-111 into the Tc-99m window.

**Data Processing**

Phillips EBW software. See Processing protocol book.

**Optional Maneuvers**

- Gastric emptying can be analyzed by methods other than determining the halftime of emptying (24-27).
• Diagnosis and treatment of gastric emptying dysfunction can be performed at one sitting (28).

• Evaluation of antral contractions: Serial 1 second images for 4 minutes are obtained after each static image. The images are analyzed to produce a record of the frequency and amplitude of antral contraction (29,30).

**Radiation Dosimetry**

**Principal Radiation Emission Data - Tc-99m (31)**

<table>
<thead>
<tr>
<th>Radiation</th>
<th>Mean % per disintegration</th>
<th>Mean energy (keV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gamma-2</td>
<td>89.07</td>
<td>140.5</td>
</tr>
</tbody>
</table>

**Dosimetry - Tc-99m-Sulfur Colloid Solid Meal (32)**

<table>
<thead>
<tr>
<th>Organ</th>
<th>rads/1 mCi</th>
<th>mGy/37 MBq</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large intestine</td>
<td>0.46</td>
<td>4.6</td>
</tr>
<tr>
<td>Small intestine</td>
<td>0.24</td>
<td>2.4</td>
</tr>
<tr>
<td>Stomach</td>
<td>0.24</td>
<td>2.4</td>
</tr>
<tr>
<td>Ovaries</td>
<td>0.08</td>
<td>0.8</td>
</tr>
<tr>
<td>Whole body</td>
<td>0.02</td>
<td>0.2</td>
</tr>
<tr>
<td>Testes</td>
<td>0.004</td>
<td>0.04</td>
</tr>
</tbody>
</table>

**References**


Normal Findings


