Austin Radiological Association
Nuclear Medicine Procedure
GASTRIC EMPTYING STUDY
(Tc-99m-Sulfur Colloid)

Overview

• The Gastric Emptying Study demonstrates the movement of an ingested bolus of solid and/or liquid from the stomach into the small intestine. Various physiologic parameters may be quantified.

Indications

• Diagnosis of functional gastric dysmotility.

Examination Time

• Variable, ranges from 90 minutes to 4 hours based on protocol selected.

Patient Preparation

• Overnight fast or at least 6 hours prior to exam.
• Prefer no opiates 48-72 hours prior to exam, no anticholinergic agents 2 days prior. Technologist notes all medications taken in last 24 hours.
• No smoking day of study
• The study should be done in the morning because the gastric emptying time varies with the time of day.
• If patient is diabetic, bring own glucometer to check BGL and own insulin. BGL must be under reasonable control: 275 or lower, or reschedule. Diabetic patients should self-administer insulin at ½ dose at time meal is ingested. Post procedure medic to check BGL before patient is released.
• All information is documented on Gastric Empty worksheet (attached).

Equipment & Energy Windows

• Gamma camera: Large or small field of view.
• Collimator: Low energy, high resolution, parallel hole.
• Energy window: 20% window centered at 140 keV.
• Computer.
Radiopharmaceutical, Dose, & Technique of Administration

- Radiopharmaceutical: A wide variety of Tc-99m-sulfur colloid labeled solid foods have been used. The preferred is Tc-99m-sulfur colloid labeled Egg Beaters or equivalent product/egg whites as part of the standard meal used with the 4 hour protocol. If patient is allergic or refuses egg, labeled cheddar cheese mixed into Easy Mac & Cheese will also work with the 4 hour protocol. For tube feeding patients use labeled Ensure Plus product.

- Dose: 1 mCi (37 MBq). Pedi dose by NACG chart.

- Technique of administration: Oral over 10 minutes or less.

- Meal consists of:
  - Labeled Egg Beaters or equivalent/egg whites
  - 2 slices toasted white bread and jam*
  - 120 ml water
  *Seven (7) Keebler Waldorf crackers may be substituted for bread
  Patients with celiac disease may substitute gluten-free bread

- Technologist notes time to ingest and amount of meal ingested. At least 50% of meal should be consumed. If patient vomits part of meal at any time during test, it should be indicated on report.

Patient Position & Imaging Field

- Patient position:
  > Adults: Sitting or Standing (4hr protocol) or Supine LAO if patient cannot sit or stand.
  > Infants: Supine.

- Imaging field: Upper abdomen. Include distal esophagus and proximal small bowel

Acquisition Protocol

4 hour exam:

- Have the patient ingest the test meal in 10 minutes or less time.

- Place the patient in sitting or standing position

- Acquire serial one hour anterior and posterior images beginning at 0 hour and continuing through hour 4, for a total of 5 anterior and 5 posterior images, for 1 minute each. If 3 hr image is calculated to be less than 10% retention, you may discontinue imaging.
Protocol Summary Diagram

Tc-99m-sulfur colloid in eggs

Action

Serial hourly images A/P from 0 hr to 4 hours

Time 0 10 min 240 min

90 minute exam (only with radiologist approval):

• Have the patient ingest the test meal in 10 minutes or less time.
• Place the patient in a supine position, LAO to the camera.
• Acquire serial 1 minute digital images continuously for 90 minutes immediately after the patient finishes ingesting the meal.

Protocol Summary Diagram

Tc-99m-sulfur colloid in oatmeal

Action

Serial digital images

Time 0 10 min 90 min

Data Processing

4 hour exam:

• Use computer software to draw a region of interest around the entire stomach on all images excluding as much small intestine as possible in each image. Exception is the immediate image – draw ROI’s to include ALL ingested activity.
• Note all counts and enter data into the Gastric Empty calculator. Enter percentage of retention at time points 1, 2, 3, and 4 hours on the Gastric Empty worksheet.
• Scan worksheet into PACS.
90 minute exam:

- Use computer software to determine emptying percentage by drawing a region of interest around the entire stomach, excluding as much small intestine as possible in each image.

- Manually: Plot the results on linear-linear graph paper with “Time” on the X-axis and “Gastric counts” on the Y-axis. Determine the gastric emptying halftime:
  1. Connect the data points with straight lines.
  2. Draw a horizontal line through the Y-axis at a point corresponding to half the maximum (initial) counts.
  3. Draw a vertical line through the time-activity curve at the point where it is intersected by the horizontal line.
  4. Read the halftime of gastric emptying from the X-axis at the point where it is crossed by the vertical line.

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

Optional Maneuvers

- Solid and liquid meal:
  1. Collimator: Medium energy, parallel hole.
  2. Energy window:
     > Tc-99m: 10% window centered at 140 keV.
     > In-111: 10% window centered at 171 keV.
  3. Radiopharmaceutical:
     > Solid: Same as for solid meal only (see above).
     > Liquid: 150 mL of water mixed with In-111-DTPA is added
  4. Dose:
     > Solid meal: 1 mCi (37 MBq).
     > Liquid meal: 250 µCi (9.25 MBq).
  5. Technique of administration: Oral.
  6. Acquisition protocol: Same as for the solid meal except acquire 2 digital images at each time period, 1 at the Tc-99m energy window and 1 at the In-111 energy window.
  7. Data processing: Same as for the solid meal except that two curves are generated: 1 for the solid meal and 1 for the liquid meal. The counts for both solid and liquid meals must be corrected for scatter. There is approximately 8% scatter from Tc-99m into the In-111 window and 23% scatter from In-111 into the Tc-99m window.
Method for timely correction of Data Analysis and reporting errors and notification of referring parties

- Data Analysis and reporting errors are reported to the interpreting physician and appropriate clinic manager for timely correction and notification of the referring physician via report addendum or STAT call if error is significant.

Principle Radiation Emission Data - Tc-99m

- Physical half-life = 6.01 hours.

<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

<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

4-hour Gastric Emptying Worksheet

1. Medications taken within the last 24 hours:
_________________________________________________________________________________

2. Diabetic? _______________No_____________ Yes_______________BGL

3. Time to ingest meal: _______________________________________________________________

4. Amount of meal ingested: __________________________________________________________

5. Any postprandial vomiting? ___________No__________Yes - amount________________________

6. Percent retention at:

<table>
<thead>
<tr>
<th>Normal Range</th>
<th>Delayed Emptying</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>1 hour</td>
<td>37 – 90%</td>
</tr>
<tr>
<td>2 hours</td>
<td>&lt; 60%</td>
</tr>
<tr>
<td>3 hours</td>
<td>&lt; 30%</td>
</tr>
<tr>
<td>4 hours</td>
<td>&lt; 10%</td>
</tr>
</tbody>
</table>

   Grading for severity of delayed emptying:

   Grade 1 (mild): 11-20% retention @ 4 hours
   Grade 2 (moderate): 21-35% retention @ 4 hours
   Grade 3 (severe): 36-50% retention @ 4 hours
   Grade 4 (very severe): >50% retention @ 4 hours

Indication of rapid emptying:

< 30% retention @ 1 hour

Consensus paper states report to include:

- Amount of meal ingested, total time taken to ingest, and if any vomiting post-prandially
- BGL if patient diabetic
- Medications taken within the last 24 hours that may affect gastric emptying
- Percentage of retention at fixed time points and normal values
- Any unusual findings – abnormal esophageal retention, hiatal hernia, fundal wrap, lack of fundic accommodation, evidence of retained food particles.

Meal consists of labeled Egg Beaters or equivalent/egg whites, two slices toast with jelly, 120 ml water. Patient is instructed to eat meal within 10 minutes.