Procedure Guideline for Gastric Emptying and Motility

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PART I: PURPOSE

The purpose of this guideline is to assist nuclear medicine practitioners in recommending, performing, interpreting and reporting the results of gastric emptying/motility studies.

PART II: BACKGROUND INFORMATION AND DEFINITIONS

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 or without liquids) and is quantitative. Serial testing can determine the effectiveness of therapy.

PART III: COMMON 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. After Response to Therapy for Previously Documented Motility Disturbances

PART IV: PROCEDURE

A. Patient Preparation
   1. Nothing by mouth for a minimum of 8 h before imaging. It is preferable to be fasting after midnight, then administer the radiolabeled meal in the morning.
   2. The patient should be advised of the logistical demands of the procedure (e.g., the meal to be ingested, the time required for imaging and the position the patient will be required to maintain throughout the study). Patients with diabetes need to be instructed to bring insulin with them. The dose of insulin is to be adjusted when the meal is given. If the patient cannot tolerate the standard solid or liquid meal study, the procedure should not be done.
   3. Premenopausal women should be studied on days 1–10 of their menstrual cycle, if possible, to avoid the effects of hormonal variation on gastrointestinal motility.
B. Information Pertinent to Performing the Procedure
   1. Related diseases, including hiatal hernia and gastroesophageal reflux
   2. Previous interventions, including medications (e.g., cisapride, metoclopramide, domperidone and erythromycin) and surgery
C. Precautions and Contraindications
   1. Allergy to the meal
   2. Fasting in patients with diabetes that results in hypoglycemia
D. Radiopharmaceuticals

The composition of radiolabeled meals varies widely. An important consideration in selection of a specific radiolabeled meal is that normal emptying rates must be established for the specific meal, patient position, imaging protocol and environment. The radiolabel stability in gastric juice for any solid meal should be established. (Table 1)

Meals are most often labeled with ^{99m}Tc-sulfur colloid and may include:

1. Solids (radiotracer is added before cooking)
   a. Eggs
      i. Scrambled
         (a) Whole eggs
         (b) Egg whites
      ii. Hard-boiled
   b. Beef stew
   c. Liver surface labeled with isotope

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Note: All 29 SNM-approved procedure guidelines are available on the Society's home page. We encourage you to download these documents via the internet at www.snm.org. If you would like information on the development of this guideline or to order a compendium of all 29 procedure guidelines for $35, contact Marie Davis, Society of Nuclear Medicine, at (703) 708-9000, ext. 250 or at the addresses given above.

TABLE 1
Radiation Dosimetry

Radiopharmaceutical	Administered activity MBq (mCi)	Organ receiving largest radiation dose* mGy (rad)	Effective dose* mSv (rem)
Nonabsorbable liquid labeled with ^{99m}Tc	7.4–14.8 (0.2–0.4)	Upper large intestine 0.13 (0.48)	0.024 (0.089)
Nonabsorbable solid labeled with ^{99m}Tc	7.4–14.8 (0.2–0.4)	Upper large intestine 0.11 (0.41)	0.024 (0.089)
Nonabsorbable liquid labeled with ^{111}In	3.7–7.4 (0.1–0.2)	Lower large intestine 2.1 (7.8)	0.3 (1.1)
Nonabsorbable solid labeled with ^{111}In	3.7–7.4 (0.1–0.2)	Lower large intestine 2.0 (7.4)	0.31 (1.1)

*Per MBq (mCi).
See reference 3, page 226 for ^{99m}Tc.
See reference 3, page 250 for ^{111}In.

2. Liquids: Almost any liquid can be used, but liquid emptying alone is not as sensitive for delayed emptying as solid or semisolid meals.
   a. Orange juice
   b. Water
   c. Milk

E. Image Acquisition

Ingestion of the radiolabeled test meal should be completed as quickly as possible, optimally within 10 min. The technologist should record how long it took to ingest the meal and if any portion of the meal was not eaten. The method should be standardized as to patient positioning and environmental conditions, such as ambient noise, lighting or other factors affecting patient comfort. The normal values should be based on this standard methodology.

1. Images are obtained in a format of at least 64 × 64 pixels using a general-purpose collimator. Recommended photopeak settings are 20% at 140 keV for ^{99m}Tc. For ^{111}In, 20% energy windows should be established around both the 172- and 246-keV photopeaks. If ^{111}In is used, a medium-energy collimator must be used for image acquisition.
2. Planar images with the distal esophagus, stomach and proximal small bowel in the field of view should be obtained immediately after ingestion of the meal.
3. Images are optimally obtained for at least 90 min, longer (2–3 h) for meals with larger volume, or higher calorie, fat, carbohydrate or protein content. Anterior and posterior views allow calculation of a geometric mean/square root of the product of the anterior region of interest (ROI) counts and more consistently represents the amount of tracer in ROI independent of anterior-posterior movement between the fundus and antrum. This can be performed sequentially using a single-head camera or, preferably, simultaneously with a two-head camera. Alternatively, the study can be acquired in the left anterior oblique view with a single-head camera. In this case, no mathematical attenuation correction is required.
4. Continuous data collection with a framing rate of 30–60 s is recommended. If data are collected only every 15 min, emptying half-time is not as accurately determined and lag phase information may be unavailable. Intermittent data acquisition may be more suitable than continuous data acquisition to image patients in an upright position.
5. Images may be obtained with the patient standing, sitting or supine, but position should not change during the study. Normal values must be established in the position used (must have separate normal values for upright and supine positions).

F. Interventions

Metoclopramide or other prokinetic drugs can be used diagnostically in conjunction with gastric emptying studies to evaluate the effectiveness of a particular therapy.

G. Processing

1. An ROI is drawn around the tracer activity in the stomach in anterior and posterior views (and/or left anterior oblique view, if acquired). Cine display may be helpful to confirm the stomach outline and to determine the extent of patient motion so that the ROI may be adjusted appropriately. Alternatively, if continuous imaging is performed, the stomach contour may be identified with initial images combined with images from later in the study, after the radiolabeled meal has had an opportunity to distribute itself within the stomach. Using initial or later images exclusively may under-represent the extent of the fundus and antrum.
2. Data points must be corrected for radioactive decay.
3. A time-activity curve obtained from the geometric mean or attenuation-corrected counts of ROI activity should then be displayed.
4. Measurements of gastric emptying may be derived and reported in several ways. Normal values should be available for the specific analysis protocol being used. The value reported as the half-emptying time

should be accompanied by a brief description of what the value represents or how the value was obtained. Values may be obtained by:
   a. Determination of the time it takes to reach half the peak counts.
   b. Least squares fit of the emptying data is used to derive a half-emptying time to reach 50% of the peak counts.
5. In addition to rate of emptying and percent emptying at the end of the study, other information may be obtained from gastric motility studies, including:
   a. Regional motility (e.g., antral contraction frequency and amplitude)
   b. Response to medical intervention
   c. Effect of varying meal composition on emptying

H. Interpretation Criteria
1. Normal values for the specific meal and environment used should be established before results can be reported.
2. Display of images in a cine format should be done to better demonstrate gastric anatomy and findings such as esophageal reflux, overlap of small bowel with gastric ROI and possible movement of gastric contents outside the drawn ROI.
3. The emptying curve generated from the ROI needs to be interpreted in light of the manner in which images were collected. For example, if only anterior imaging was performed, a "plateau phase" may represent gastric emptying at the same time posterior-to-anterior movement of tracer is occurring within the stomach.
4. Previous surgical procedures and current medications should be considered during interpretation of findings.

I. Reporting
1. The meal, imaging protocol and techniques for data analysis should be outlined in the report.
2. The gastric emptying data reported should be compared with normal values.
3. The study should be compared with previous studies, if available. If the previous study protocol differed from the current study (e.g., type of meal, position patient was in during imaging), the differences should be reported.
4. Any medications currently being taken that may alter gastric emptying should be documented.

J. Quality Control

The meal ingested must be controlled for caloric content (amount of carbohydrate, fat and protein), volume and temperature.

K. Sources of Error
1. Before a liquid meal is administered to an infant or to a patient with severe neurologic impairment through a feeding tube, an abdominal radiograph should be obtained to ensure that the meal is placed in the stomach, not the lung or small bowel.
2. Poor labeling
3. Nonstandard meal
4. Marked variation in the environment such as noise, lighting or temperature during imaging
5. Emotional fluctuations such as fear of the medical environment, anxiety about results or anger after a long wait for the study to begin
6. Nausea caused by a meal that may be unfamiliar to the patient
7. Patient has eaten just before the study
8. Slow movement of the ingested meal from the mouth or esophagus into the stomach
9. Gastroesophageal reflux
10. Overlap of small bowel activity with the stomach ROI
11. Prolonged length of time for patient to ingest the meal
12. Lack of attenuation correction, particularly in obese patients
13. Failure to recognize that patient has not eaten entire meal

PART V: DISCLAIMER

The Society of Nuclear Medicine has developed guidelines to promote the cost-effective use of nuclear medicine procedures. These generic recommendations cannot be applied to all patients in all practice settings. The guidelines should not be deemed inclusive of all proper procedures or exclusive of other procedures reasonably directed to obtaining the same results. The spectrum of patients seen in a specialized practice setting may be quite different than the spectrum of patients seen in a more general practice setting. The appropriateness of a procedure will depend in part on the prevalence of disease in the patient population. In addition, the resources available to care for patients may vary greatly from one medical facility to another. For these reasons, guidelines cannot be rigidly applied.

Advances in medicine occur at a rapid rate. The date of a guideline should always be considered in determining its current applicability.

PART VI: ISSUES REQUIRING FURTHER CLARIFICATION

A. Intrasubject variability
B. Effect of environmental conditions on emptying rate
C. Effect of meal volume, composition, texture, etc. on emptying rate
D. Range of normal values for various meals in selected populations (specific age ranges, hormonal and emotional states)
E. Effect of hormonal variation on emptying/motility
F. Gender differences in emptying/motility

PART VII: CONCISE BIBLIOGRAPHY

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PART VIII: LAST HOUSE OF DELEGATES APPROVAL DATE

February 7, 1999

PART IX: NEXT ANTICIPATED APPROVAL DATE

2001