GASTRIC EMPTYING STUDY (SOLID)

Aim

To evaluate patients with symptoms of altered of gastric emptying and/or motility, and quantitatively measure the rate of gastric emptying. This study provides a physiologic, non-invasive and accurate measure of gastric emptying in patients with indications such as:

- Postprandial
    - Nausea, vomiting
    - Upper abdominal discomfort, bloating
    - Chronic aspiration
- Suspected gastroparesis
- Poor diabetic control
- Gastroesophageal reflux
- Following response to therapy for previously documented motility disturbances

Background

The stomach normally empties its contents into the duodenum within two to six hours. A variety of pathologic conditions can alter the normal emptying rate of the stomach's contents. These disorders can be divided into delayed gastric emptying and rapid gastric emptying. Increased rate of emptying occur with dumping syndromes, hyperthyroidism, gastrinomas (Zollinger-Ellison disease). Impairment of gastric motility and a subsequent decrease in the rate of gastric emptying occur with conditions such as diabetic gastroparesis, hypothyroidism, connective tissue disorders and pyloric stenosis or obstruction.

By monitoring the emptying of a caloric controlled meal from a patient's stomach, the rate of emptying can be calculated.

Radiopharmaceutical

^{99m}Tc Calcium Phytate Colloid added to 2 egg whites.

Dose: 50 MBq

Meal Preparation

- Break 2 eggs and remove the yoke.
- Beat or whisk the remaining egg whites until fluffy.
- Add ^{99m}Tc Calcium Phytate Colloid to beaten egg whites and cook in microwave for 2-3 minutes.
- Spread jam on 2 pieces of white bread.

- Place the cooked egg whites in between the 2 pieces of bread and make a sandwich.

Dosimetry

Organs	Absorbed Dose (mGy/MBq)
Spleen	$7.50 \cdot 10^{-2}$
Liver	$7.10 \cdot 10^{-2}$
Gall bladder	$2.00 \cdot 10^{-2}$
Pancreas	$1.30 \cdot 10^{-2}$
Adrenals	$1.20 \cdot 10^{-2}$
Red marrow	$1.10 \cdot 10^{-2}$
Stomach	$6.40 \cdot 10^{-3}$

Effective dose ($mSv \cdot MBq^{-1}$): $9.40 \cdot 10^{-3}$

Patient Preparation

Patients are required to fast for at least 6 hours before the study.

Medication that can interfere with gastric empting should be discontinued. These include narcotic analgesics, anticholinergics, antidepressants, calcium channel blockers, gastric acid suppressant and aluminium containing antacids.

N.B. Discontinuation of medication is at the discretion of the doctor.

For Diabetic Patients

Measure the BSL (Blood Sugar Level) when the patient arrives for the procedure.

For IDDM, instruct the patient to bring their insulin and at the time of meal ingestion, half of the normal insulin dose should be self administered.

Scanning Protocol

- Seat the patient at table set with absorbent material in case of spill.
- Provide the patient with gloves to wear to avoid contamination.
- Give patient the egg sandwich and 1 cup of water (120 mL).
- Instruct the patient to eat the egg sandwich with sips of water (if required) within 5 minutes. If the patient is unable to consume the whole meal, at least 50% of each component should be eaten.
- The acquisition of images should commence as soon as the patient has consumed the meal.

Acquisition Parameters – Initial Dynamic

Parameter	Discovery 670	Infinia Hawkeye 4	Millennium MG
Energy Session	^{99m}Tc	^{99m}Tc	^{99m}Tc
Energy Peak (keV)	140.0	140.0	140.0
Energy Window (%)	+/- 10	+/- 10	+/- 10
Collimator	LEHR	LEHR	LEHR
Matrix Size	128 x 128	128 x 128	128 x 128
Zoom	1	1	1
Detectors (1 and/or 2)	1 and 2	1 and 2	1 and 2
Detector Orientation	0	0	0
Patient Orientation	Feet first, Supine	Feet first, Supine	Feet first, Supine
Number of Frames:	60	60	60
Time per Frame (seconds)	60	60	60

Acquisition Parameters – 2 Hour and 4 Hour Statics (If required)

Parameter	Discovery 670	Infinia Hawkeye 4	Millennium MG
Energy Session	^{99m}Tc	^{99m}Tc	^{99m}Tc
Energy Peak (keV)	140.0	140.0	140.0
Energy Window (%)	+/- 10	+/- 10	+/- 10
Collimator	LEHR	LEHR	LEHR
Matrix Size	256 x 256	256 x 256	256 x 256
Zoom	1	1	1
Detectors (1 and/or 2)	1 & 2	1 & 2	1 & 2
Detector Orientation	0	0	0
Patient Orientation	Feet first, Supine	Feet first, Supine	Feet first, Supine
Time (seconds)	600	600	6OO

Image Analysis

- Select the patient.
- Activate the SVH New Gastric Emptying Application, under User Applications.
- When prompted, draw a ROI around the stomach on the composite image, making sure to include the fundus and the antrum of the stomach and excluding loops of small bowel in close proximity to the stomach. Then press proceed.
- Next, adjust ROIs for 0 Hour image on the anterior and posterior planes and then press proceed.
- Then adjust ROIs for 2 Hour image on the anterior and posterior planes and then press proceed.
- Lastly, adjust ROIs for 4 Hour image on the anterior and posterior planes and press proceed.
- The program calculates the geometric mean (GM) of the anterior and posterior gastric counts for each time point and corrects for ^{99m}Tc decay (6.02 hour half life), where GM count = (anterior counts x posterior counts)$^{1/2}$

- The results are expressed as percent remaining in the stomach at each time point with the total gastric counts normalized to 100% for the time *t = 0*

Scan Interpretation

The antrum of the stomach is responsible for solid gastric emptying and this can be categorised into two phases: the initial delay before the emptying or otherwise termed as the lag phase and the subsequent continuous emptying phase.

The lag phase is due to the time required for the transfer of food from the fundus to the antrum and the antrum to grind food into small particles to pass through the pylori into the duodenum.

Delayed GE

Delayed GE can be observed in patients with gatroparesis, which is associated with symptoms such as nausea, vomiting, early satiety, postprandial fullness and abdominal discomfort and pain.

Gastric motility is abnormal in approximately 25% of diabetic patients with autonomic neuropathy. Diabetic patients with elevated blood glucose levels have been shown to empty more slowly than those with lower blood glucose levels. These patients display a delayed GE with a prolonged lag phase.

Patients with connective tissue diseases such as scleroderma, gastric involvement is observed in about 50% of patients with gastrointestinal disease.

Rapid GE

Rapid GE is a major factor in dumping syndrome, usually observed after surgery for peptic ulcer disease with or without vagotomy.

Normal Limit of Gastric Retention

Time	% Retention
1 Hour	37-90%
2 Hours	30-60%
4 Hours	0-10%

References

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2. Donohoe *et el*. (2004) Society of Nuclear Medicine Procedure Guideline for Gastric Emptying and Motiity Version 2.0

3. International Commission of Radiological Protection (1998), Radiation Dose to Patients from Radiopharmaceuticals (Addendum to ICRP Publication 53). ICRP Publication 80, *Annals of the ICRP* 28 (3)

4. Ziessman H.A., Fahey F.H., Atkins F.B. and Tall J. (2004) Standardization and Quantification of Radionuclide Solid Gastric-Emptying Studies *The Journal of Nuclear Medicine* **45** (5) 760-764