Optimization and Standardization of Gastric Emptying: Getting the Most Out of this Valuable Diagnostic Tool.

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Purpose/Objective

We will review the consensus guidelines for performing standardized solid and liquid gastric emptying studies (GES). We will describe the classification of abnormal gastrointestinal motility. We will discuss the interpretative criteria for GES. Lastly, we will discuss a future GES research direction, intragastric differential distribution.

Disclosure/Disclaimer

The authors have no disclosures relevant to this research.

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Background

Gastrointestinal diseases are a pervasive medical problem, representing almost 20 percent of primary care visits and incurring approximately $30 billion in healthcare costs each year. The breadth and heterogeneity of clinical presentations create significant diagnostic and therapeutic challenges for both primary care physicians and subspecialists alike.

The most common presenting symptom is dyspepsia which may manifest as any combination of epigastric pain, nausea, vomiting, and bloating. GES offers the combination of a noninvasive, physiologic test that provides both qualitative and quantitative motility data.

Unfortunately, GES initially suffered from a lack of standardization including differences in meal, patient positioning, frequency/duration of image acquisition as well as variations in the quantitative data reported. In 2007, the SNMMI formulated easy-to-follow guidelines for GES, including preparation, exam performance, and reporting. Despite being adopted by both the ACR and SNMMI, a decade later Farrell and colleagues found that only 3% of nuclear medicine practices were compliant with the 2007 protocol.

SNMMI 2007 Solid GES Guidelines

- Patient preparation
  - Withhold medications that may impact GES for 2-3 days
    - Prokinetics (continue if assessing for response)
    - Gastric motility inhibitors: narcotics, anticholinergics, antispasmodics
  - Fast overnight
  - No tobacco products/vaping on day of exam
  - Diabetics: Fasting glucose control < 275 mg/dL

- Based upon 2000 Tougas et al. protocol
  - Sandwich with 2 egg-whites, 1 packet of jam, and 120mL of water
  - 18.5-37MBq (0.5-1 mCi) ^{99m}Tc-SC in egg-whites.
  - Low fat meal (~255 kcal)
  - Consume complete meal ≤ 10 mins

- Image at 4 time points
  - Whole abdomen at T = 0
  - Stomach at T = 1, 2 and 4-hrs
  - Consider including 30-mins acquisition to assess for early emptying abnormalities

- Interpretation
  - Utilize published gastric emptying curves with normal upper and lower limits for each time point.

Liquid GES Guidelines

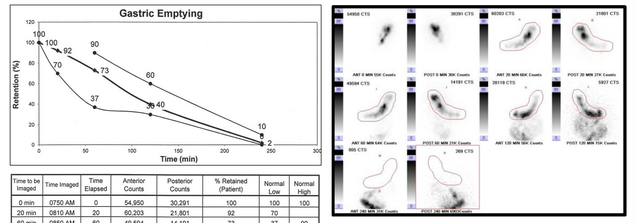
- Patient preparation:
  - Similar to solid preparation

- Based upon 2009 Ziessmann et al. *JNM* article
  - 300mL of water mixed with 7.4MBq (0.2 mCi) ^{111}In-DTPA, while lying semiupright on hospital bed

- Image at 30 time points
  - Stomach and upper abdomen at 1 min frames for 30 mins

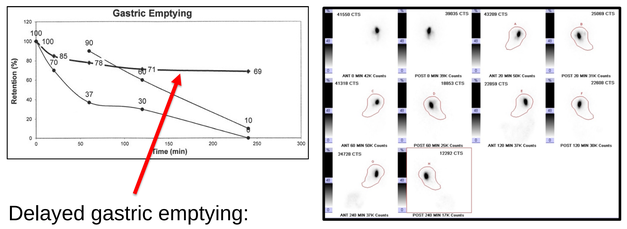
- Interpretation
  - Upper range of normal was $T_{1/2}$ = 22 mins for 3 SDs and 19 mins for 2 SDs.
  - Average normal $T_{1/2}$ was 14.3 +/- 5.3 mins.

Figure 1. Normal GES



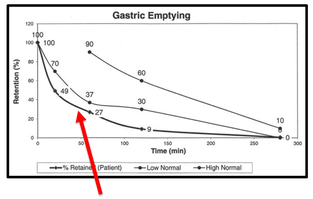
Time to be Imaged	Time Imaged	Time Elapsed	Anterior Counts	Posterior Counts	% Retained (Patient)	Normal Low	Normal High
0 min	0750 AM	0	54,950	30,291	100	100	100
20 min	0810 AM	20	60,203	21,801	92	70	
60 min	0850 AM	60	49,594	14,191	73	37	90
120 min	0950 AM	120	28,119	5,927	40	30	60
240 min	1150 AM	240	805	269	2	0	10

Figure 2. Delayed GES

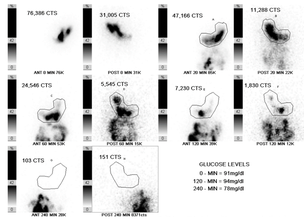


Delayed gastric emptying:
- > 60% retention at 2-hrs
- > 10% retention at 4-hrs

Figure 3. Rapid GES



Rapid gastric emptying:
- < 70% retention at 30 mins
- < 30% retention at 1-hr

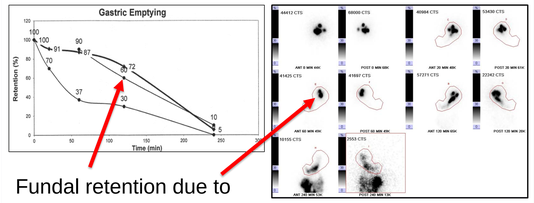


Results from: early diabetes, cyclic vomiting syndrome, functional dyspepsia, or post-op

Intragastric distribution

- In response to food bolus, there is a normal relaxation of the fundus to accomodate food.
- Subsequently an intragastric pressure gradient from fundus to antrum results in movement of the food bolus.
- Proper relaxation at the antrum results in opening for passage of the food bolus.

Figure 4. Delayed fundal GES



Fundal retention due to diminished intragastric pressure gradient.
- Delayed and excess fundal retention.
- Can normalize at the end as in this GES.

Figure 5. Delayed antral GES

Antral retention due to abnormal signaling resulting in delayed opening of the gastric antrum.
- Excess retention at the gastric antrum
- Possible normal gastric emptying early

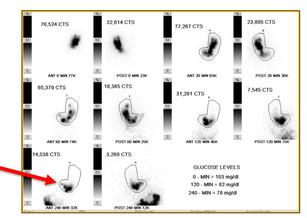
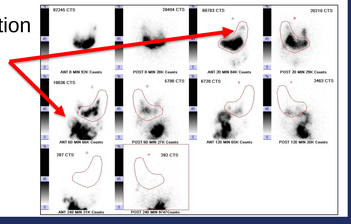


Figure 6. Delayed antral GES

Poor fundal relaxation results in rapid gastric emptying.



Conclusions

GES is a useful diagnostic modality in the evaluation of gastrointestinal disease, providing a qualitative and quantitative assessment of gastric motility under physiologic conditions.

Due to the persistent variation in the practice of GES, despite long standing national guidelines endorsed by several stakeholder societies, it is important that radiologists and nuclear medicine physicians be knowledgeable about its proper performance and interpretation.