Original Article

Measurement of Gastric Emptying Time: Correlation between Scintigraphic Technique and Radiopaque Marker Technique

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Background: Gastric emptying scintigraphy (GES) is the gold standard technique for evaluating gastric emptying time (GET). Radiopaque marker technique (ROMT) is the gold standard for colonic transit time, but it is rarely used to quantify GET.

Objective: To compare measurement of GET between ROMT and gold standard GES.

Materials and Methods: Healthy volunteers were recruited to undergo simultaneous ROMT and GES at the largest national tertiary referral center in Thailand. A standardized solid meal of 267 Kcal was administered followed by 2 capsules containing 25 radiopaque markers (ROMs). Images of both techniques were captured at pre-established time points. Interpretation was recorded as percentage of retention (% retention) of both radionuclide substance and ROMs at each time point.

Results: Nineteen healthy volunteers (11 females) with a mean age of 38.5±12.5 years, and a mean body mass index (BMI) of 22.9±2.3 kg/m^2 were recruited. The mean percentage of retention by GES at 0.5, 1, 2, 3, and 4 hours was 92.7, 65.6, 21.3, 6.2, and 2.6, respectively. ROMT analyses revealed mean % retention at 1, 2, 4, and 6 hours of 99.6, 95.2, 48.5, and 22.1, respectively. The Spearman's rank correlation coefficient between techniques was 0.8 (p<0.001). After excluding first-hour ROMT data, linear regression analysis revealed a correlation coefficient of 0.57 between tests (p<0.001). The interclass correlation coefficient between interpreters was 0.97.

Conclusion: A moderate correlation between ROMT and GES was demonstrated. ROMT evaluated from the second to the fifth hour can be considered in patients with gastroparesis when GES is not available.

Keywords: Gastric emptying scintigraphy, Gastric emptying time, Measurement, Radiopaque marker technique

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Upper gastrointestinal symptoms, including early satiety, postprandial fullness, nausea, vomiting, bloating, and upper abdominal pain, are commonly observed in routine clinical practice. A recent review found epigastric pain, early satiety, and nausea to be commonly observed symptoms in 40 to 90% of patients with uninvestigated dyspepsia, especially in Southeast Asia[1]. Gastroparesis is defined as delayed gastric emptying accompanied by the aforementioned gastrointestinal symptoms, but without demonstrated physical obstruction. Dyspepsia and gastroparesis have similar and overlapping symptoms[2], so it is difficult to differentiate these two conditions based on symptoms alone. In addition to subtle clinical differences between these two conditions, they are also managed similarly, but the prognosis of each is different. Diagnosis of functional dyspepsia is made according to ROME criteria, while a diagnosis of gastroparesis requires confirmation by gastric emptying studies.

Gastric emptying scintigraphy (GES) is currently considered the gold standard method for diagnosing gastroparesis[3,4]. Other diagnostic methods include wireless capsule motility testing, and ^{13}C breath testing using octanoate or spirulina[5,6]. However, these diagnostic methods are not yet widely available, especially in developing countries. The high prevalence of the aforementioned gastrointestinal symptoms and the relative unavailability of several diagnostic techniques suggests a need for a simpler and more widely available screening method. Radiopaque marker technique (ROMT) is currently the gold standard method for measuring colonic transit time. This test is used to distinguish patients with delayed colonic transit time from

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normal transit chronic constipation patients. ROMT is simple, inexpensive, and easy to implement in general hospitals with x-ray services. ROMT measures gastrointestinal transit time by quantifying the number of radiopaque markers remaining in the gastrointestinal tract over time. In patients with upper gastrointestinal symptoms, gastric emptying time (GET) is the evaluated parameter. Since GES is not widely available and ROMT is the gold standard technique for colonic transit time, we speculated that ROMT may be equally efficacious for measuring GET. Accordingly, the aim of this study was to compare the measurement of GET between ROMT and gold standard GES.

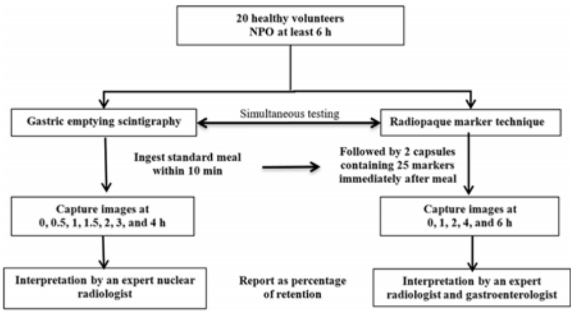

Figure 1. Flow diagram describing the study protocol.

Materials and Methods

This prospective cohort study in healthy volunteers with no gastrointestinal symptoms was conducted at the Division of Gastroenterology, Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand during June to October, 2012 study period. All volunteers were non-smokers, and none reported taking any medications that affect gastric motility. Patients with one or more of the followings were excluded: pregnancy, history of previous major abdominal surgery (simple appendectomy, tubal sterilization, and laparoscopic cholescystectomy were allowed), dysphagia, inflammatory bowel diseases, diabetes mellitus, and/or BMI >30 kg/m^2. General health status and demographic data were collected and recorded, after which participants were scheduled for evaluation according to the study protocol. The protocol for the present study was approved by the Siriraj Institutional Review Board (SIRB) (COA No. Si350/2012). The present study complied with all of the principles set forth in the Declaration of Helsinki (1964) and all of its subsequent provisions. Written informed consent was obtained from all study participants.

Study protocol

All subjects fasted for 6 hours before undergoing simultaneous GES and ROMT. All volunteers consumed a standardized 267 Kcal solid meal, which was immediately followed by 2 capsules containing a total of 25 radiopaque markers that were taken with 100 ml of water. Gamma camera and radiography were used to capture images of gastric content retention at different time points (gamma camera for GES at 0, 0.5, 1, 1.5, 2, 3, and 4 h; and, plain abdominal radiography for ROMT at 0, 1, 2, 4, and 6 h). The duration between the two imaging techniques was not more than five minutes at each time point. The study protocol is given in Figure 1. Any abdominal discomfort and gastrointestinal symptoms were recorded at 24 hours and seven days after the procedure. GES results were evaluated and reported by a single nuclear radiologist (PP). All plain radiographic images were independently reviewed by two doctors (PL is a radiologist, and MM is a gastroenterologist). The percentage of retention of radionuclide substance, and the number of radiopaque markers at each time point were recorded. Association between the 2 techniques was evaluated at each time point, and interpretation agreement between the two interpreters was evaluated for ROMT.

Gastric emptying scintigraphy (GES)

GES was performed according to standard protocol. Each participant received a standardized and validated Thai meal that is radiolabeled with ^{99m}Tc phytate/sulfur colloid to facilitate assessment of solid phase gastric emptying[7]. The meal consists of 100 grams of steamed rice, a microwaved labeled chicken egg (egg size 65 to 70 grams mixed with 5 ml of vegetable oil, 10 ml of water, and 37 MBq of ^{99m}Tc phytate for labeling), followed by 100 ml of drinking water. The total energy of the meal is 267 kcal (57% carbohydrate, 23% fat, and 19% protein). Soy sauce was provided for seasoning, and subjects were requested to finish their meal within 10 minutes. The 1st image (0 hour) was taken by gamma camera immediately after the participant finishing the meal. The next images were captured at the 0.5, 1, 1.5, 2, 3, and 4-hour time points. All images were taken in the standard 45 degree left anterior oblique and standing positions. All results were interpreted and reported as percentage of gastric retention by a single experienced nuclear radiologist who was blinded to the results of the ROMT test.

Radiopaque marker technique (ROMT)

Two capsules containing a total of 25 radiopaque markers were provided to each participant. Capsules were ingested immediately after the standardized meal. Our aim was to assess marker retention in the stomach at each time point using plain abdominal radiography. The capsules were made of hard gelatin, and they were taken with 100 ml of water. The capsules are easily dissolved in the stomach after ingestion. The radiopaque markers are inert, made of cylindrically-shaped plastic, and sized 1 mm by 5 mm. Radiographs were obtained in the supine position at each time point according to the study protocol. Two interpreters, an experienced radiologist and a gastroenterologist, analyzed and reported the results as percentage of radiopaque markers retained in the stomach. The two interpreters assessed the results independently, and both were blinded to the result of gastric scintigraphy.

Sample size calculation and statistical analysis

The sample size for this study was calculated using a linear regression equation with a standard normal distribution of 1.96, 5% probability of a type 1 error, and 80% power. We used a 0.56 correlation coefficient that was reported from a prior similar study[8]. The calculated sample size of 18 subjects was then increased by 10% to 20 participants to compensate for incomplete data.

Descriptive statistics were used to summarize demographic and clinical data. Categorical data are presented as number and percentage, and continuous data are shown as mean, standard deviation and range. Spearman's rank correlation coefficient was used to evaluate association between the two techniques. Linear regression and weighted least squares regression were employed to analyze association and changes at different time points between techniques. Intraclass correlation coefficient was used to evaluate the reproducibility of ROMT interpretation by assessing the agreement of ROMT interpretation between two readers. A two-sided *p*-value less than 0.05 was considered statistically significant. All data analyses were performed using PASW Statistics version 18.0 (SPSS, Inc., Chicago, IL, USA).

Results

Twenty volunteers who met the inclusion criteria were enrolled. One subject was subsequently excluded due to a technical error that occurred during scintigraphy. The remaining 19 subjects (11 females and 8 males) were included in the final analysis. The mean age was 38 years (range: 18 to 60), the mean body mass index was 23 kg/m^2, the mean body weight was 61 kilograms, and all patients had a sthenic build. Patient baseline demographic and clinical characteristics are shown in Table 1. All subjects completed the study protocol without periprocedural complication. Gastro-intestinal symptoms were re-evaluated by telephone interview at 1 week after the procedure, and no gastrointestinal complaints were reported.

The mean percentage of gastric retention as determined by GES at 0.5, 1, 2, 3, and 4 hours was 92.7, 65.6, 21.3, 6.2, and 2.6 respectively. All of those percentages were within normal range according to Thai population database (Table 2). Percentage of retained gastric content over time in all subjects as determined by GES is shown in Figure 2.

The mean percentage of radiopaque marker retention as determined by ROMT at 1, 2, 4, and 6 hours was 99.6, 95.2, 48.5, and 22.1, respectively (Table 3). Percentage of retained gastric content over time in all subjects as determined by ROMT is shown in Figure 3. Only 7 (36.8%) subjects were able to completely empty all ROMs from their stomach within 6 hours. In contrast, the other 12 (63.2%) subjects demonstrated marker retention in the stomach at the 6th hour. The proportion of retained markers ranged from 4 to 72%. Imaging from one study participant of gastric content retained at different time points according to ROMT and GES is shown in Figure 4.

The correlation of percentages of gastric retention between techniques using Spearman's rank correlation

Table 1. Demographic data of the study population

Characteristics	Total (n = 19)	Female (n = 11)	Male (n = 8)
Age (year)	38.5 (12.5)	38.7 (10.4)	38.3 (5.9)
Body weight (kg)	38.5 (12.5)	58.1 (6.5)	64.8 (7.9)
Body mass index (kg/m^2)	22.9 (2.3)	23.3 (2.2)	22.4 (2.4)
Underlying disease*, n (%)	4 (21.1)	3 (15.8)	1 (5.3)

Data are expressed as mean (standard deviation) unless specified.
* Underlying diseases included hypertension, asthma, dyslipidemia, and migraine headache
SD = standard deviation

Table 2. Percentage of gastric retention as determined by gastric emptying scintigraphy (GET)

Time after ingestion (hr)	n	Mean (SD)(%)	Range (%)
0.5	19	92.7 (5.6)	80.7 to 100.0
1	19	65.6 (8.8)	41.7 to 81.2
1.5	19	38.7 (11.1)	13.7 to 52.7
2	19	21.3 (9.1)	4.0 to 37.8
3	19	6.2 (4.1)	0.3 to 14.8
4	19	2.6 (2.7)	0 to 8.5

coefficient test revealed a correlation coefficient of 0.8 (p<0.001). When changes at different time points were taken into account, the correlation coefficient from linear regression analysis was 0.36 (p<0.001) (Figure 5A). When we compared the results of the two techniques on first-hour imaging, we observed a lag period for ROMT compared to GES. We hypothesized that this may have been due to slow capsule dissolution. Accordingly, we decided to reanalyze the data excluding first-hour ROMT data. That reanalysis compared GES data at 0, 0.5, 2, and 4 hours with ROMT data at 0, 2, 4, and 6 hours. The correlation coefficient after the exclusion of first-hour ROMT data was 0.57 (p<0.001) (Figure 5B).

Concerning the consistency of ROMT interpretation between 2 readers (PL and MM), the interclass correlation coefficient of 0.97 indicated very good inter-rater reliability (p<0.001) (Figure 6).

Discussion

Previous studies[8-11] compared GES with various techniques to evaluate gastric function and transit time. Those investigations may partially reflect the impracticality and/or limited availability of GES. The results of these studies suggest the need for a test that is affordable, easy to implement, and widely available. The present study demonstrated a correlation between GES and ROMT for evaluation of gastric emptying time with a correlation coefficient between tests of 0.57 (p<0.001). This moderate correlation is similar to the correlation reported from a prior study[8] even though we used different statistics to calculate and compare ROMT with GES. We also observed close to parallel slopes when comparing between GES and ROMT relative to gastric retention over time (Figure 2 and 3), and this observation was consistent with previous study. When we scrutinized the hourly changes between tests, the emptying of ROMs was a bit delayed compared to the emptying of the digestible solid meal, especially at the first hour after ingestion. The authors also observed that there was complete emptying of ROMs at the 6th hour in 7 cases. These suggested a pattern of ROMs emptying, in a part of population, seems to follow an all or none pattern.

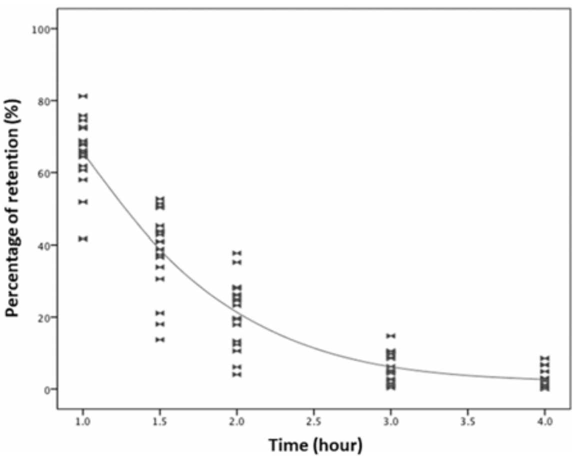

Figure 2. Percentage of retained gastric content over time in all subjects as determined by gastric emptying scintigraphy (GES); X represent percentage of retained gastric content of individual subject at each time point. The line indicates the average of percentage of retained gastric content over time.

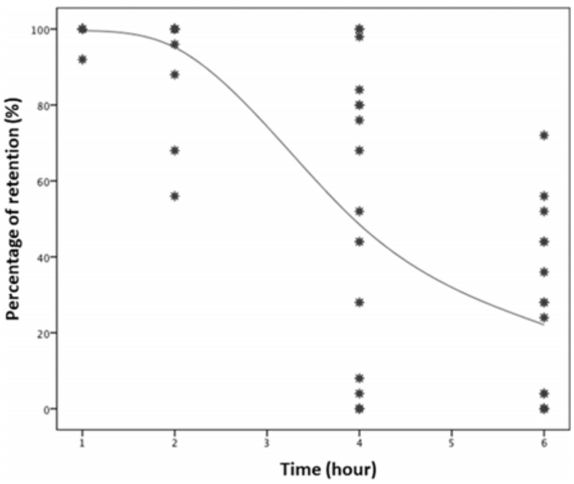

Figure 3. Percentage of gastric content retained over time in all subjects as determined by radiopaque marker technique (ROMT); * represent percentage of retained radiopaque markers of individual subject at each time point. The line indicates the average of percentage of retained radiopaque markers over time.

Table 3. Percentage of gastric retention as determined by radiopaque marker technique (ROMT)

Time after ingestion (hr)	n	Mean (SD)(%)	Range (%)
1	19	99.6 (1.8)	92 to 100
2	19	95.2 (12.2)	56 to 100
4	19	48.5 (41.2)	0 to 100
6	19	22.1 (23.4)	0 to 72

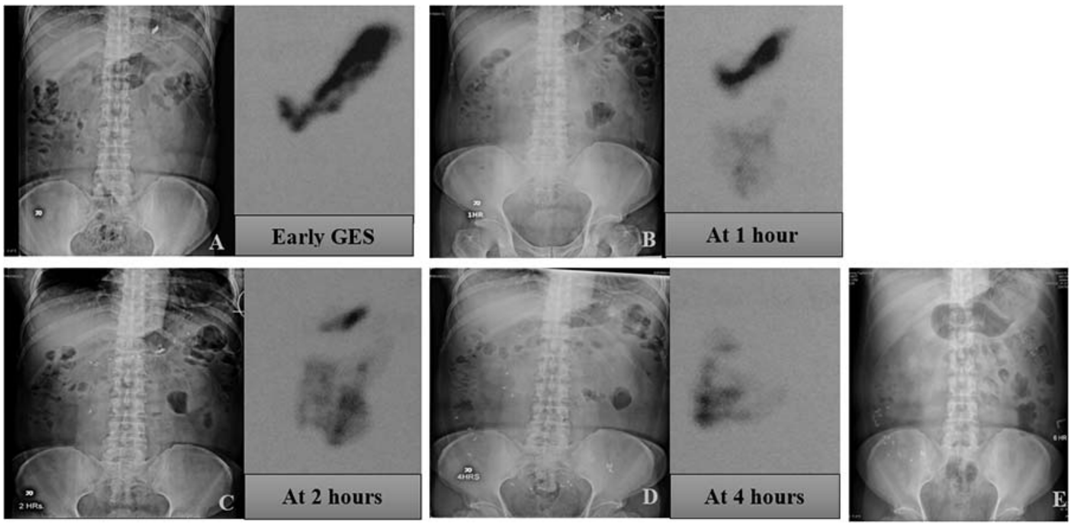

Figure 4. Imagings of a study participant demonstrated the retaining of gastric content by the radiopaque marker technique and the gastric scintigraphy technique. These were taken simultaneously at different time points as displayed.

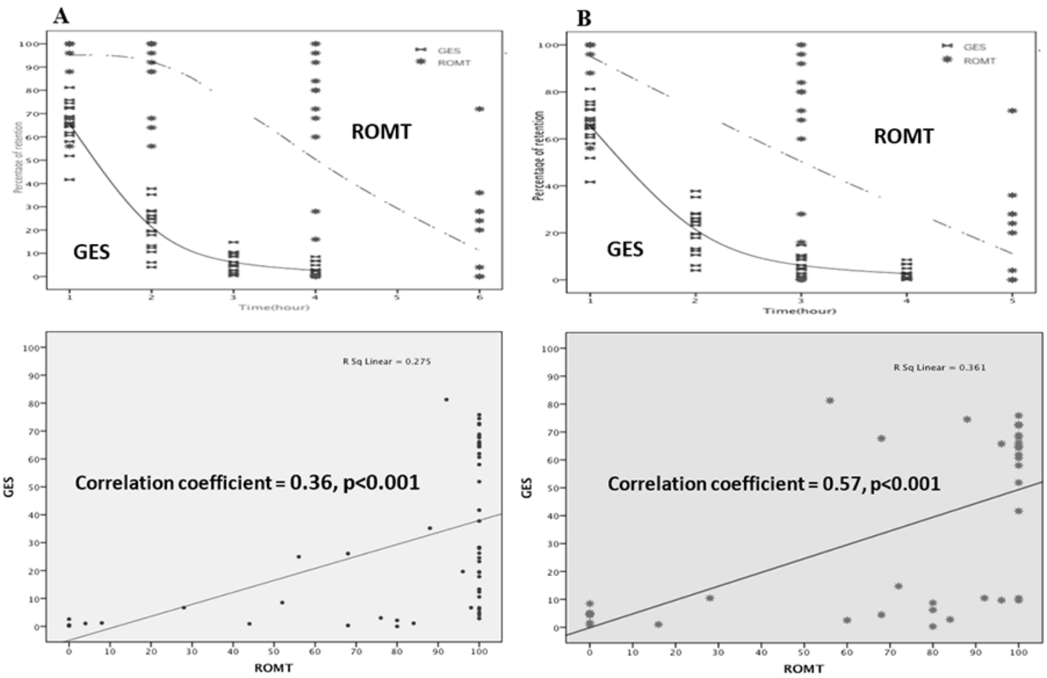

Figure 5. Plots describing the percentage of retained gastric content compared between the gastric scintigraphy technique and radiopaque marker technique (A). The same comparison between techniques excluding the first hour of ROMT data (B). The lower panels reveal the correlation coefficients between the 2 techniques. Exclusion of the first hour of ROMT data increased the correlation coefficient from 0.36 to 0.57.

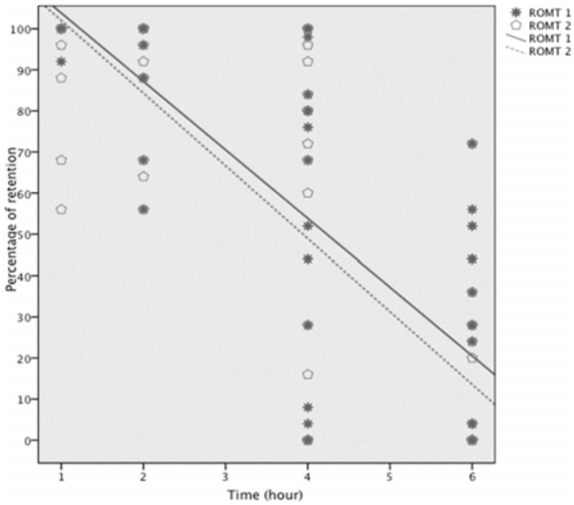

Figure 6. A plot describing agreement between a gastroenterologist and a radiologist relative to determining the percent retention of radiopaque markers over time.

The factors that may have influenced a difference between ROMT and GES testing included the following. First, the characteristics of the markers and the capsule used to deliver the markers may have precipitated a difference; however, there is no data to support this theory. All reported data showed no significant difference in emptying time, even when different sizes, shapes, and densities of markers were used[8,11-13]. Second, delayed emptying during the first hour in ROMT may be explained by the dissolution time of the gelatin capsule, as we could see appearance of aggregated markers in capsule shape at the early hour after capsule ingestion. Third, the particles in the ingested solid meal may have affected gastric motility. The mixture of solid foods measured by gastric scintigraphy (i.e., digested rice and egg particles) was largely liquified and homogenous, which facilitated easy transit across the pylorus overtime. In contrast, the markers were solid, larger, and indigestible; hence, they may have been retained longer in the gastric antrum during the emptying phase, and they had a higher possibility of being retro-propulsive during the retropulsive phase. Fourth, the bowel gas pattern and volume visualized on the plain abdominal radiograph varied by participant, and this may have caused variations in the ability of the interpreters to visualize the markers. In order to mitigate this potential confounder, we decided to take the plain abdominal radiographs with the participant laying in the supine position instead of in the upright position. We found the gas pattern and volume issue to be less problematic when images were captured in the supine position. We also compared the results of the 2 radiograph interpreters, both of whom are experienced in abdominal radiograph interpretation. The intraclass correlation coefficient between the two interpreters was an excellent 0.967, which indicated very high inter-rater reliability ($p<0.001$). In order to adjust for the first hour lag period between tests that was caused by differences in gastric functions relative to how different types of particles move through the gastrointestinal system, we decided to reanalyze our data after excluding first-hour ROMT data. The results of this reanalysis resulted in an improvement in the correlation coefficient between techniques from 0.36 to 0.57 (Figure 5).

The techniques for assessing gastric emptying time that are accepted by both the American and European Neurogastroenterology and Motility Societies include gastric emptying breath test (GEBT), wireless motility capsule, and gastric emptying scintigraphy[6]. Several other techniques have been studied and published. Specifically, gastric sonography, magnetic resonance imaging, and breath testing using various types of agents have been described for use in different settings and circumstances[10,14-28]. The fact that these other measurement methods have been explored seems to suggest the relative unavailability of the recommended methods. It should also be noted that different tests measure different parameters. Meal tests are likely to demonstrate not only gastric emptying time, but also gastric function overtime, while the capsule test measures the gastric residence time of the capsule. The results of this study suggest the combined value of a meal followed by ROMs ingestion. Further evaluation for test validity in patients to obtain normative values in both healthy and diseased people using the local meal is required.

Conclusion

The results of this study revealed a moderate correlation between ROMT and GES for measurement of gastric emptying time. This result is consistent with the results of prior studies. Since ROMT is affordable, easy to perform, and widely available in most hospitals, this test might be considered as a screening tool for assessing gastric emptying time in patients with suspected gastroparesis when GES is not available. The results from this study suggest the second to the fifth hour after meal as the optimal time for interpretation. In contrast, gold standard GES is optimally evaluated from the first to the fourth hour after meal. Further study in gastroparesis patients is needed to identify a gastric emptying cutoff point so that only one plain radiographic image of the abdomen is needed in order to avoid unnecessary radiation exposure to the patient. Further studies to identify optimal normative values for ROMT in patients with delayed gastric emptying are eagerly awaited.

What is already known on this topic?

Gastric emptying scintigraphy (GES) is the gold standard technique for evaluating gastric emptying time (GET). However, the test is expensive, not easy to perform and not practical in routine medical service. Radiopaque marker technique (ROMT) is the gold standard for colonic transit time, easy to perform and could be provide widely. ROMT has not been used as a standard tool for quantifying GET.

What this study adds?

There was a moderate correlation between gastric emptying scintigraphy and radiopaque marker technique. Apply radiopaque marker technique as a screening tool for evaluating gastric emptying in routine clinical practice is feasible, especially in resource limited area. Further studies are required to qualify the validity not only in healthy volunteer, but also in the patients.

Conflicts of interest

The authors declare no conflict of interest.

References

1. Mahadeva S, Ford AC. Clinical and epidemiological differences in functional dyspepsia between the East and the West. Neurogastroenterol Motil 2016;28:167-74.
2. Lacy BE. Functional dyspepsia and gastroparesis: one disease or two? Am J Gastroenterol 2012;107:1615-20.
3. Abell TL, Camilleri M, Donohoe K, Hasler WL, Lin HC, Maurer AH, et al. Consensus recommendations for gastric emptying scintigraphy: a joint report of the American Neurogastroenterology and Motility Society and the Society of Nuclear Medicine. J Nucl Med Technol 2008;36:44-54.
4. Abell TL, Camilleri M, Donohoe K, Hasler WL, Lin HC, Maurer AH, et al. Consensus recommendations for gastric emptying scintigraphy: a joint report of the American Neurogastroenterology and Motility Society and the Society of Nuclear Medicine. Am J Gastroenterol 2008;103:753-63.
5. Camilleri M, Parkman HP, Shafi MA, Abell TL, Gerson L. Clinical guideline: management of gastroparesis. Am J Gastroenterol 2013;108:18-37; quiz 8.
6. Rao SS, Camilleri M, Hasler WL, Maurer AH, Parkman HP, Saad R, et al. Evaluation of gastrointestinal transit in clinical practice: position paper of the American and European Neurogastroenterology and Motility Societies. Neurogastroenterol Motil 2011;23:8-23.
7. Vasavid P, Chaiwatanarat T, Pusuwan P, Sritara C, Roysri K, Namwongprom S, et al. Normal solid gastric emptying values measured by scintigraphy using Asian-style meal: A multicenter study in healthy volunteers. J Neurogastroenterol Motil 2014;20:371-8.
8. Stotzer PO, Fjalling M, Gretarsdottir J, Abrahamsson H. Assessment of gastric emptying: comparison of solid scintigraphic emptying and emptying of radiopaque markers in patients and healthy subjects. Dig Dis Sci 1999;44:729-34.
9. Olausson EA, Brock C, Drewes AM, Grundin H, Isaksson M, Stotzer P, et al. Measurement of gastric emptying by radiopaque markers in patients with diabetes: correlation with scintigraphy and upper gastrointestinal symptoms. Neurogastroenterol Motil 2013;25:e224-32.
10. Pfaffenbach B, Wegener M, Adamek RJ, Wissuwa H, Schaffstein J, Aygen S, et al. Non-invasive 13C octanoic acid breath test for measuring stomach emptying of a solid test meal—correlation with scintigraphy in diabetic patients and reproducibility in healthy probands. Z Gastroenterol 1995;33:141-5.
11. Loreno M, Bucceri AM, Catalano F, Blasi A, Brogna A. Gastric clearance of radiopaque markers in the evaluation of gastric emptying rate. Scand J Gastroenterol 2004;39:1215-8.
12. Horikawa Y. Gastric emptying of three different size of indigestible radiopaque markers in healthy subjects. J Smooth Muscle Res 1998;34:83-8.
13. Smith HJ, Feldman M. Influence of food and marker length on gastric emptying of indigestible radiopaque markers in healthy humans. Gastroenterology 1986;91:1452-5.
14. Banerjee S, Dixit S, Fox M, Pal A. Validation of a rapid, semiautomatic image analysis tool for measurement of gastric accommodation and emptying by magnetic resonance imaging. Am J Physiol Gastrointest Liver Physiol 2015;308:G652-63.
15. Bluemel S, Menne D, Fried M, Schwizer W, Steingoetter A. On the validity of the (13) C-acetate breath test for comparing gastric emptying of different liquid test meals: a validation study using magnetic resonance imaging. Neurogastroenterol Motil 2015;27:1487-94.
16. Choi MG, Camilleri M, Burton DD, Zinsmeister AR, Forstrom LA, Nair KS. [13C]octanoic acid breath test for gastric emptying of solids: accuracy, reproducibility, and comparison with scintigraphy. Gastroenterology 1997;112:1155-62.
17. Coletta M, Gates FK, Marciani L, Shiwani H, Major G, Hoad CL, et al. Effect of bread gluten content on gastrointestinal function: a crossover MRI study on healthy humans. Br J Nutr 2016;115:55-61.
18. Dennie J, Atiee G, Warren V, Tao B, Morimoto K, Senaldi G. A phase 1 study to assess the safety, tolerability, pharmacokinetics, and pharmacodynamics of single oral doses of DS-3801b, a motilin receptor agonist, in healthy subjects. J Clin Pharmacol 2017;57:1221-30.
19. Gopirajah R, Raichurkar KP, Wadhwa R, Anandharamakrishnan C. The glycemic response to fibre rich foods and their relationship with gastric emptying and motor functions: an MRI study. Food Funct 2016;7:3964-72.
20. Hamada SR, Garcon P, Ronot M, Kerever S, Paugam-Burtz C, Mantz J. Ultrasound assessment of gastric volume in critically ill patients. Intensive Care Med 2014;40:965-72.
21. Hayakawa N, Nakamoto Y, Chen-Yoshikawa TF, Kido A, Ishimori T, Fujimoto K, et al. Gastric motility and emptying assessment by magnetic resonance imaging after lung transplantation: correlation with gastric emptying scintigraphy. Abdom Radiol (NY) 2017;42:818-24.
22. Lee JS, Camilleri M, Zinsmeister AR, Burton DD, Choi MG, Nair KS, et al. Toward office-based measurement of gastric emptying in symptomatic diabetics using

[13C]octanoic acid breath test. Am J Gastroenterol 2000;95:2751-61.
23. Liu D, Parker HL, Curcic J, Kozerke S, Steingoetter A. Emulsion stability modulates gastric secretion and its mixing with emulsified fat in healthy adults in a randomized magnetic resonance imaging study. J Nutr 2016;146:2158-64.
24. Matsuzaki J, Suzuki H, Masaoka T, Tanaka K, Mori H, Kanai T. Influence of regular exercise on gastric emptying in healthy men: a pilot study. J Clin Biochem Nutr 2016;59:130-3.
25. Mirbagheri N, Dunn G, Naganathan V, Suen M, Gladman MA. normal values and clinical use of bedside sonographic assessment of postoperative gastric emptying: a prospective cohort study. Dis Colon Rectum 2016;59:758-65.
26. Mori H, Suzuki H, Matsuzaki J, Taniguchi K, Shimizu T, Yamane T, et al. Gender difference of gastric emptying in healthy volunteers and patients with functional dyspepsia. Digestion 2017;95:72-8.
27. Schmitz A, Schmidt AR, Buehler PK, Schraner T, Fruhauf M, Weiss M, et al. Gastric ultrasound as a preoperative bedside test for residual gastric contents volume in children. Paediatr Anaesth 2016;26:1157-64.
28. Valeur J, Berstad A, Hausken T. The effect of body position on postprandial perceptions, gastric emptying, and intragastric meal distribution: an ultrasonographic study in reclining healthy subjects. Scand J Gastroenterol 2015;50:170-3.

การตรวจวัดเวลาการส่งผ่านของกระเพาะอาหารโดยเปรียบเทียบระหว่างการตรวจทางเวชศาสตร์นิวเคลียร์ และการใช้เม็ดยาแคปซูลบรรจุวัตถุทึบแสงร่วมกับภาพถ่ายทางรังสีวิทยา

มณฑิรา มณีรัตนะพร, ศิริพร สรรพโรจน์พัฒนา, ปิยาภรณ์ อภิสารธนรักษ์, ภาวนา ภูสุวรรณ, สมชาย ลีลากุศลวงศ์

ภูมิหลัง: การวัดเวลาการส่งผ่านอาหารของกระเพาะอาหารโดยวิธีทางเวชศาสตร์นิวเคลียร์ถือเป็นการตรวจมาตรฐานในการตรวจวัดเวลาการส่งผ่านอาหารของกระเพาะอาหาร การตรวจด้วยการกลืนวัสดุทึบแสงร่วมกับการถ่ายภาพรังสีเพื่อการนี้ แม้จะทำได้ง่าย แต่ยังไม่มีการใช้อย่างแพร่หลาย

วัตถุประสงค์: เพื่อเปรียบเทียบการวัดเวลาการส่งผ่านอาหารของกระเพาะอาหารโดยวิธีทางเวชศาสตร์นิวเคลียร์ กับการตรวจด้วยการกลืนวัสดุทึบแสง

วัสดุและวิธีการ: อาสาสมัครสุขภาพดีได้เข้ารับการตรวจวัดเวลาการส่งผ่านอาหารของกระเพาะอาหารโดยวิธีทางเวชศาสตร์นิวเคลียร์ และการตรวจด้วยการกลืนวัสดุทึบแสงในเวลาเดียวกัน โดยทั้งหมดจะได้รับมื้ออาหารมื้อมาตรฐานของการตรวจทางเวชศาสตร์นิวเคลียร์ แล้วกลืนแคปซูล 2 เม็ด แต่ละเม็ดบรรจุวัสดุทึบแสงจำนวน 25 อัน จากนั้นจะได้รับการถ่ายภาพทั้ง 2 วิธีตามเวลาที่กำหนดไว้ และการแปลผลภาพถ่ายดังกล่าวจะประเมินจากร้อยละของสิ่งที่เหลืออยู่ในกระเพาะอาหาร

ผลการศึกษา: จากอาสาสมัครสุขภาพดี 19 ราย (เพศหญิง 11 ราย) มีอายุเฉลี่ย 38.5±12.5 ปี ค่าดัชนีมวลกายเฉลี่ย 22.9±2.3 กิโลกรัม/ตารางเมตร โดยมีอาหารที่เหลือค้างในกระเพาะอาหาร ณ เวลาที่ 0.5, 1, 2, 3, และ 4 ชั่วโมง คิดเป็นร้อยละ 92.7, 65.6, 21.3, 6.2, และ 2.6 ตามลำดับ ส่วนการประเมินจำนวนวัสดุทึบแสงในกระเพาะอาหาร ณ เวลาที่ 1, 2, 4, และ 6 ชั่วโมงคิดเป็นร้อยละ 99.6, 95.2, 48.5, และ 22.1 ตามลำดับ เมื่อพิจารณาสิ่งที่เหลือค้างในกระเพาะอาหารจากทั้ง 2 วิธีแล้วประเมินความสัมพันธ์ด้วยวิธีสเปียร์แมน จะได้ค่าสัมประสิทธิความสัมพันธ์คิดเป็น 0.8 (ค่าพีน้อยกว่า 0.001) และเมื่อตัดค่าการตรวจวัดด้วยการกลืนวัสดุทึบแสง ณ ชั่วโมงที่ 1 ออก การประเมินความสัมพันธ์ของ 2 วิธี ตามเวลาที่ผ่านไป ด้วยการวิเคราะห์การถดถอยแบบเป็นเส้นตรง พบค่าสัมประสิทธิ์ความสัมพันธ์เท่ากับ 0.57 (ค่าพีน้อยกว่า 0.001) และเมื่อพิจารณาความสอดคล้องของการแปลผลภาพถ่ายรังสีโดยแพทย์ 2 ฆน พบว่ามีฆ่าสัมประสิทธิ์สหสัมพันธ์ภายในชั้นเท่ากับ 0.97

สรุป: การวัดเวลาการส่งผ่านอาหารของกระเพาะอาหาร โดยวิธีการตรวจทางเวชศาสตร์นิวเคลียร์ และการใช้เม็ดยาแคปซูลบรรจุวัตถุทึบแสงร่วมกับภาพถ่ายทางรังสีวิทยามีความสัมพันธ์กันปานกลาง เนื่องจากการตรวจด้วยการใช้เม็ดยาแคปซูลบรรจุวัตถุทึบแสงร่วมกับภาพถ่ายทางรังสีวิทยาที่เวลา 2 ถึง 5 ชั่วโมง อาจพิจารณาใช้ในการตรวจคัดกรองในที่ที่ไม่สามารถตรวจโดยวิธีทางเวชศาสตร์นิวเคลียร์ได้