

How to Interpret a Functional or Motility Test - Slow Nutrient Drinking Test

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The gastric barostat study is the gold standard method for evaluating gastric perception and accommodation. This technique has serious drawbacks, such as expense and invasiveness. Several drinking tests have been developed as noninvasive methods. Such tests are easily performed without special instruments and are well tolerated. We have reported that (1) a threshold volume inducing mild bloating in the slow nutrient drinking test might be an alternative parameter of gastric accommodation volume as determined by the barostat method and (2) the maximum satiety volume in the drinking test correlated positively with the pressure to induce severe discomfort in healthy volunteers, indicating that the slow nutrient drinking test may be useful for evaluating accommodation volume and the threshold to induce severe discomfort. However, the correlation between the maximum satiety drinking volume and accommodation volume as measured by the barostat study has been controversial. Therefore, validation of a certain nutrient drink test for measuring gastroduodenal function might be recommended in each institution.

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Key Words

Accommodation; Drinking; Perception

Introduction

The gastric barostat study is the gold standard method for evaluating gastric perception and accommodation,¹⁻³ despite some criticism.⁴ However, this technique has serious drawbacks, such as expense and invasiveness. Several drinking tests have been developed as noninvasive methods to assess gastric perception and accommodation.^{1-3,5-7} Such tests are easily performed without special instruments and are well tolerated. The initial

study of the satiety drinking test reported in 1998 by Tack et al¹ demonstrated a good correlation with the results of barostat studies in the dyspepsia patients. Recently, good reproducibility of the drinking test has been shown.⁸ In contrast, other investigators have found that drinking tests are a less sensitive predictor of impaired accommodation or visceral hypersensitivity than the barostat study.⁹ Park¹⁰ has already interpreted nutrient drink test in this session. In the same year, we reported, for the first time in Asia, a slow nutrient drinking test as a useful functional test for evaluating gastric accommodation and perception.¹¹ This paper

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mainly deals with our slow nutrient drinking test, and shows the issues of this test.

Procedure of Our Nutrient Drinking Test

The test is performed after fasting for more than 6 hours. An examinee receives 15 mL of a liquid meal (Ensure-H[®]; 1.5 kcal/mL, 31.5% fat, 54.5% carbohydrate, 14.0% protein; Abbott Japan, Tokyo, Japan) in a paper cup every 1 minute, and the subject is ordered to continue drinking the liquid meal through a straw at a rate of 15 mL/min and to score satiation on a scale graded 0-5 at 5-minute intervals. An examinee is instructed to cease drinking when his/her score reaches 5 (maximal satiation) or they ingest 1,500 mL. The actual volume of Ensure-H[®] consumed at this point is the maximum satiety volume. Bloating sensation is also asked to be scored on a scale graded 0 (none) to 3 (severe) at every 5 minutes.

Useful Parameters and Normal Values for Nutrient Drinking Test

To compare the slow nutrient drinking test with the barostat method, 18 male volunteers (mean age 31.3 ± 5.4 [SE] years; range 25-44 years) participated. None of the subjects had any history of gastrointestinal disease, nor were taking any medications. The barostat system was set up as reported previously.^{1,2} Minimal distending pressure (MDP) was first determined by increasing the intrabag pressure by 1 mmHg at every 3 minutes until a volume of ≥ 30 mL was reached.

Gastric perception

Perception of gastric fundus against distension was examined with isobaric distensions in stepwise increments of 2 mmHg starting from MDP for 2 minutes using a barostat device.^{1,2} Subjects were instructed to score feelings in the upper abdomen at the end of every distending step by the following rating scale: 0, no perception; 1, weak/vague; 2, weak but significant; 3, moderate/vague; 4, moderate but significant; 5, severe discomfort; and 6, unbearable pain. The end point of each sequence of distensions was established at an intrabag volume of 750 mL or when the subject reported unbearable pain (score 6).

First perception (score 1, $n = 18$), severe discomfort (score 5, $n = 15$) and unbearable pain (score 6, $n = 15$) were reported at distended pressures of 11.7 ± 1.0 , 17.7 ± 0.8 and 20.3 ± 0.8 mmHg, respectively, over MDP.

Gastric accommodation

The bag pressure level was set at MDP + 2 mmHg. After 20 minutes, the subject was requested to drink 200 mL of

Ensure-H[®] through a straw over the course of 5 minutes. Recording of dyspepsia symptoms was continued for ≥ 60 minutes after the meal. Gastric tone before and after administration of the meal was measured by calculating the mean balloon volume for consecutive 1-minute intervals. The mean preprandial intra-gastric balloon volume at MDP + 2 mmHg was 172 ± 15 mL. Two minutes after drinking, the balloon volume was significantly greater than the mean preprandial volume. The peak volume (mean 330 ± 28 , 270-390 mL) was achieved 9 minutes after drinking and remained significantly elevated until 60 minutes postprandially. Maximal gastric volume recorded after drinking was determined as the "peak accommodation volume," which was 452 ± 27 mL.

Normal values for nutrient drinking test

The drinking test described above was conducted on another day, at a maximum of 4 weeks from the barostat study. The volumes inducing first perception and maximum satiety were distributed from 75 to 300 mL (mean 133 ± 14), and from 345 to 1,500 mL (mean 731 ± 72), respectively. All subjects complained of bloated sensation, and the threshold volume inducing the first bloated sensation was 75-1,275 mL (mean 283 ± 66).

Useful parameters of nutrient drinking test

Pressure inducing severe discomfort (score 5) correlated positively with maximum satiety volume in the drinking test ($r = 0.60$, $P = 0.017$). Accommodation volume (postprandial peak gastric volume) in the barostat study showed a significant correlation ($r = 0.59$, $P = 0.027$) with a threshold volume inducing bloating in the drinking test, but no correlation ($r = 0.38$, $P = 0.183$) with satiety volume.

Issues and implications on accommodation

The gastric accommodation reflex is a slow-onset reflex after the ingestion of a meal. The optimal time frame for evaluation of meal-induced accommodation has not been established.^{1,12} We analyzed peak value of postprandial proximal gastric volume. Peak value reflected well the bloated feeling. Changes in the proximal gastric volume after achieving peak accommodation showed various patterns over 1 hour. Analyzing the time course of gastric emptying, Zai et al¹³ demonstrated that dynamic changes in gastric outflow occurred at an early postprandial stage. They predicted that expulsion of a high-osmolarity liquid meal which was not adequately diluted by gastric juices, into the duodenum could result in strong inhibition of gastric emptying.¹³ The inhibitory effect of nutrients in the duodenum on gastric emptying could be long lasting.¹⁴ It has been suggested that impaired gastric accommodation relates to excessive gastric outflow

in the very early postprandial period and delayed gastric emptying may be induced not only by gastric dysmotility but also by too rapid gastric emptying in the very early postprandial period.¹³ In addition, our preliminary findings demonstrated that the time to reach peak volume reflected the initial changing point of the gastric emptying pattern, as determined by simultaneously monitoring the proximal volume using a barostat and emptying by the breath test,¹⁵ suggesting that the time to reach peak volume reflected achieving the adaptive relaxation reflex. Therefore, peak postprandial gastric volume might more intimately reflect the physiological adaptive reflex reaction, namely the accommodation phenomenon. Again, the accomplishment of gastric accommodation controlled gastric emptying rate in a part and gastric emptying was regulated by accommodation with harmonization.

Interpreting Test Results

Our results suggested that 'a threshold volume to induce bloating' and 'the maximum satiety volume' in the nutrient drinking test may respectively reflect fundic accommodation volume and intragastric pressure inducing severe discomfort in the barostat study in healthy volunteers. The nutrient drinking tests were performed by a similar method that Tack et al¹ have reported previously regarding the rate (15 mL/min) and caloric density (1.5 kcal/mL) of liquid meal. However, they demonstrated a lack of correlations between parameters obtained by their nutrient drinking test and barostat utilized study in the healthy volunteers, in contrast to ours. In one hand, Chial et al¹⁶ reported the gender and age-related differences in the maximum tolerated (satiety) volume of a nutrient drink and postprandial symptoms.

These findings indicate that comparison with the standard method is necessary on considering the sexuality, age or presence of functional dyspepsia for interpreting measured values in drinking test. Namely, standardization of the drinking test and evaluation as to whether the drinking test can measure the aimed values, such as gastroduodenal function and gastric perception, might be recommended in each institution. Thereafter, we can use the test, for example, for evaluation of pathophysiology of functional dyspepsia and for interpretation of a certain drug effect on gastric function in terms of accommodation and/or perception.

The maximum satiety volume has been unexceptionally reported to be smaller in functional dyspepsia patient than healthy volunteers in the drinking test, regardless of the method. Further studies should be necessary to clarify the implication of this constant phenomenon from the viewpoints of gastroduodenal functions at many institutions

Conclusion

Our slow nutrient drinking test may be useful for evaluating the threshold to induce severe discomfort and accommodation volume in volunteers. Validation of a certain nutrient drink test for measuring gastroduodenal function might be warranted in each institution.

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