

Gastric Accommodation in Normal Thai Adults : Assessed by Single Photon Emission Computed Tomography (SPECT) Scanning

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ABSTRACT

Background: Assessment of gastric accommodation is important for the diagnosis of motility disorders, such as functional dyspepsia and diabetic gastroparesis. Currently, barostat measurement is the gold standard for the assessment of gastric accommodation in NUD but its disadvantage is the invasive technique. A non-invasive method using single photon emission computed tomography (SPECT) has been developed and is promising for this investigation.

Objective: To assess the normal value of gastric accommodation (post-prandial/fasting gastric volume ratio) by SPECT in healthy Thai adults.

Materials and Methods: Following an overnight fast, ten minutes after intravenous injection of 5 mCi ^{99m}Tc pertechnetate, SPECT scanning was performed, imaging was performed during fasting and over 3 minutes (two camera orbits) following ingestion of a 300 ml. Panenteral through a straw. Transaxial images of the stomach were rendered with DICOM to reconstruct three dimensional images and to measure gastric volumes during the fasting and post-prandial periods. Fasting and postprandial gastric volumes were measured by SPECT scanning.

Results: Twenty-seven healthy volunteers (14 females, 13 males; mean age 41.3 ± 10.0 years (range 21-60) were included. Average height, weight, and body mass index were 161.1 ± 8.0 m, 59.6 ± 9.3 kg, and 22.9 ± 2.5 kg/m², respectively. Following an overnight fast, Meal-induced relaxation was induced by panenteral 300 ml/300 kcal. Median fasting gastric volume (V_f) and post prandial volum (V_p) were 167.41 ml (range 61.2-555.1) and 397.1 ml (range 90.8-918.1) respectively. V_p/V_f ratio was 2.0 (5th-95th percentile 1.1-6.5) Prevalence of impaired gastric accommodation which defined as less than 5th percentiles of V_p/V_f ratio was 3.7% (1/27). Sex, BMI and age has no effect on V_p/V_f ratio

Conclusions: This is the first study of gastric accommodation measured by SPECT scanning in Thailand. Impaired gastric accommodation in this study means V_p/V_f less than 1.1. We hope, this value may be used as a reference for any future study on gastric accommodation in Thailand.

Key words : Gastric Accommodation, Thai Adults, SPECT scanning

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BACKGROUND

Gastric accommodation is a vagally mediated reflex that occur post-prandially. It consists of a relaxation of the gastric fundus; and meal was provided with a reservoir, which enabling volume increase without the rise in pressure. Subsequently, meal is emptied from stomach at a rate that matches absorptive capacity of the duodenum.⁽¹⁻³⁾ However, if this process is impaired, so call "impaired gastric accommodation", upper gastrointestinal symptoms such as distension, bloating, early satiety, will occur.⁽¹⁾ Several conditions which associated with impair gastric accommodation are non-ulcer dyspepsia, post fundoplication, rumination syndrome, post vagotomy and diabetes mellitus.^(2,3) Studies of gastric accommodation have been performed in non-ulcer dyspepsia, post fundoplication or even normal subject.⁽³⁻¹¹⁾

Several techniques such as gastric barostat, single photon emission computed tomography [SPECT], MRI, ultrasound, satiety drinking test and water load test have been proposed for measurement of gastric accommodation.^(1-3,5-8,11) Gastric barostat was the first method being used, and it is generally regarded as the gold standard for quantifying gastric post-prandial relaxation.^(1,2) The invasive nature of this procedure limit its clinical usage. Both ultrasound and MRI are less invasive tests, but require further validation.^(1,6)

SPECT scanning has been proposed as a new radionuclide scan technic for measuring gastric accommodation.⁽²⁾ It provides an assessment of the whole stomach volume by radioactive imaging.^(2,6) ^{99m}Tc-pertechnetate is given intravenously and the isotope is taken up and excreted by parietal and mucous cells throughout the stomach.⁽⁶⁾ The gamma ray is detected by gamma camera and then the imaging is interpreted by computer software.^(2,6) (Figure 1). The validity of SPECT comparing to gastric barostat have been documented.^(4,12) The results of both studies showed that the ratio of post-prandial gastric volume and fasting gastric volume (V_p/V_f), so called accommodation ratio, are comparable. Kim DY, *et al.*⁽⁶⁾ measured gastric accommodation in healthy and non-ulcer dyspepsia by SPECT. They defined impaired gastric accommodation as when the accommodation ratio (V_p/V_f) was less than 5th percentile; and in the healthy group the accommodation ratio was between 5th-95th percentile.

Measurement of gastric accommodation by

SPECT scanning has never been studied in Thailand. The objectives of the present study was to assess gastric accommodation in normal Thai adults by SPECT scanning.

MATERIALS AND METHODS

Study Population

Twenty-seven healthy Thai volunteers, ages over 18 years were recruited to this study. All were screened with questionnaires and taken physical examination to ensure there were no abnormal GI symptoms. The exclusion criteria were (1) history of peptic ulcer, dyspepsia, GERD (2) serious medical illness (3) diabetes (4) thyroid disease (5) pregnancy (6) current medication which affect gastric motility, and (7) previous abdominal surgery especially gastric surgery

Study Protocol

The study protocol consisted of : (1) physical examination (2) laboratory tests (3) SPECT scanning.

Physical Examination

From each participants, the biographic data and physical findings were obtained. Last menstrual cycle was obtained to exclude pregnancy.

Laboratory Test

Laboratay investigations were performed on the same day with the SPECT scanning. The tests included CBC, blood chemistry, fasting blood sugar, liver function test, urine analysis and urine pregnancy test.

SPECT Scanning

Twenty-seven participants (13 males, 14 females) were studied following an overnight fast and were stoped smoking and all alcoholic drink during the preceeding 24 hrs. All the participants had two per technetate SPECT sessions.

The subjects were put into supine position (Figure 1). Ten minutes after intravenous injection of 5 mCi ^{99m}Tc-pertechnetate, time for uptake of the isotope by the gastric mucosa, the first SPECT scan (fasting gastric volume; V_f) were taken by a double orbit gamma camera (Forte, Philip). On completion of the fasting SPECT scan, 300 ml of panenteral (1:1 concentration, 306.4 kcal; protein 9.2 g, carbohydrate 32.7 g, fat 15.4 g) were administered orally. The second SPECT scan (post-prandial gastric volume; V_p) was

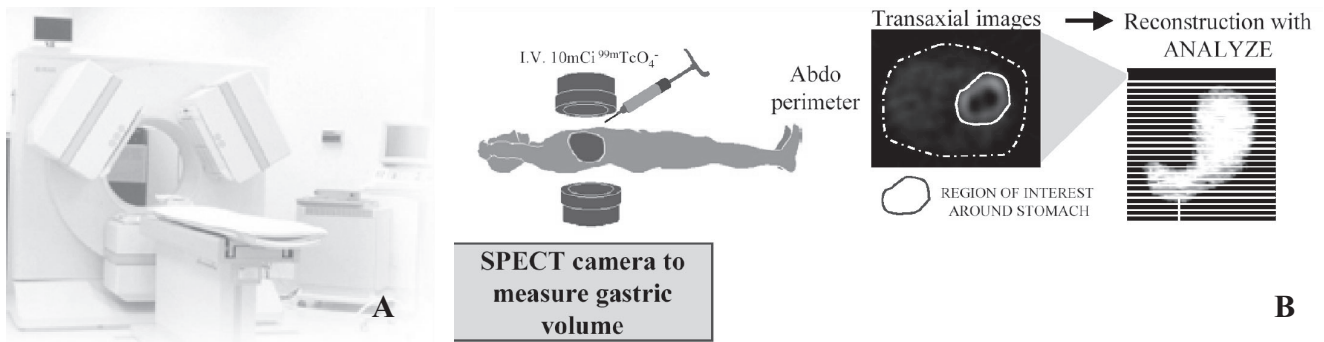


Figure 1 SPECT scanning
 A gamma camera
 B step of gastric volume measurement using SPECT scan

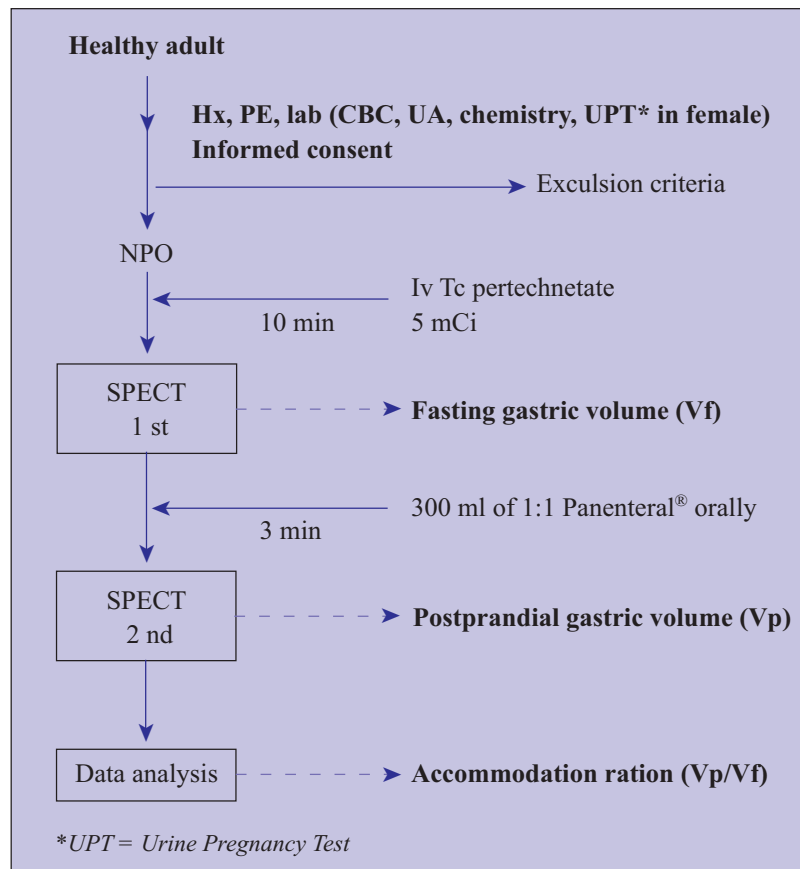


Figure 2 Diagram of protocol flow chart in this study

performed at 3 minutes after ingestion the test meal. (Figure 2)

Gastric Volume Calculation

For estimation of gastric volume, the transaxial images from SPECT scan were transferred via computer software (DICOM). Three-dimensional surface rendered images of the stomach were produced, and total gastric volumes were automatically measured.

End Points

- We set study's end points as follows
- Primary end point was normal range of gastric accommodation measured by SPECT
 - Secondary end points were the prevalence of impaired gastric accommodation and the correlation of gastric accommodation to other factors such as age, sex and BMI

Statistical Analysis

- The gastric accommodation is represented by ratios of post prandial volume and fasting volume (V_p/V_f). Normal gastric accommodation are equal to 5th-95th percentiles and if the ratio was less than 5th percentiles the gastric accommodation was impaired⁽⁶⁾.

- Demographic data (age, body weight, height, BMI) were reported as mean \pm SD.

- Gastric volume (V_p , V_f and ratio) were reported as median (min - max).

- Correlation of accommodation ratio to age, accommodation ratio to BMI were assessed by Spearman's correlation coefficient.

- Correlation of accommodation ratio to sex were assessed by Mann-Whitney U test.

RESULTS

A total of 27 participants (13 male, 14 female) were enrolled with a nearly equally distributed by gender and age group.

The average age was 41.3 ± 10 years, average weight was 59.6 ± 9.3 kg, average height was 161.1 ± 8 cm and average BMI was 22.9 ± 2.5 kg/m².

Nobody was excluded from the study

Gastric Volume and Accommodation Ratio (Table 3)

The median value of post-prandial volume, fasting volume and accommodation ratio were 397.1, 167.4

Table 1 Demographic data

N	27
Age (yr \pm SD)	41.3 ± 10
Male (%)	48.1
Weight (kg \pm SD)	59.6 ± 9.3
Height (cm \pm SD)	161.1 ± 8
BMI (kg/m ² \pm SD)	22.9 ± 2.5

Table 2 Distribution of study population by age and sex

Age	M (n = 13) (48.1 %)	F (n = 14) (51.9 %)
18-30	2	3
31-40	5	4
41-50	3	4
≥ 50	3	3

Table 3 Gastric volume measured by SPECT

	All n = 27	Male n = 13	Female n = 14
V_p (ml)	397.1 (90.8 - 918.1)	391.6 (90.8-705.6)	510.9 (129.8-918.1)
V_f (ml)	181.3 (61.2-555.1)	154.9 (85.8-289.8)	168.6 (129.8-918.1)
V_p/V_f ratio	2.0 (1.1-7.6)	2.0 (1.1-4.6)	2.4 (1.2-7.6)

and 2.0 respectively.

The normal accommodation ratios were 1.1-6.5 and impaired gastric accommodation ratio was 1.1 (5th percentiles). In this study only one subject (3.7%) had accommodation ratio less than 1.1

There was no correlation of gastric accommodation to age, BMI and sex. The correlation coefficient between accommodation ratio and BMI were 0.27 ($p = 0.17$), accommodation ratio and age were 0.57 ($p = 0.78$). There was no difference in median value of accommodation ratio between male and female ($p = 0.15$).

DISCUSSION

Before started this study, the SPECT scanning had been validated by measuring the phantom volume (data did not show). This ensured the accuracy of the SPECT used in our study.

Prevalence of impaired gastric accommodation in normal Thai adults from our data was 3.7 percent which was comparable to Kim's study (5 percent).

The value of the accommodation ratios from the present study was less than those from the Kim's study⁽⁶⁾, however, it were comparable to those of the other two studies.^(4,12)

Our study is in agreement with Bouras' study⁽⁴⁾, that is the accommodation ratios were not affected by other factors such as gender, age and body mass index.

Comparing to Kim's study⁽⁶⁾ in the aspect of methodology, there were two main differences. Firstly, we used ^{99m}Tc-pertechnetate in a dose of 5 mCi instead of 10 mCi. Because the available data suggested that the decreasing dose of radionuclide substance do not affect the image quality, on the other hand, it brings a lesser amount of radiation exposure to the participants. Secondly, from Kim's study, they performed a-double-

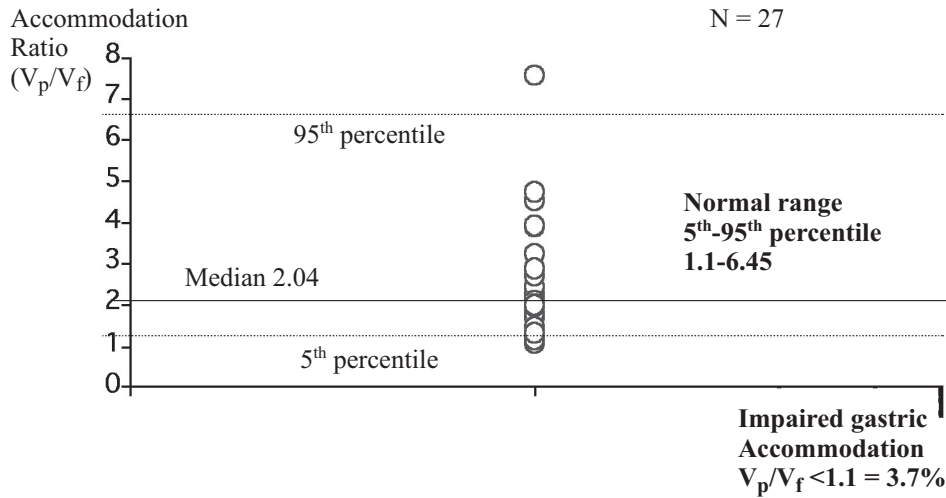


Figure 3 Distribution of gastric accommodation

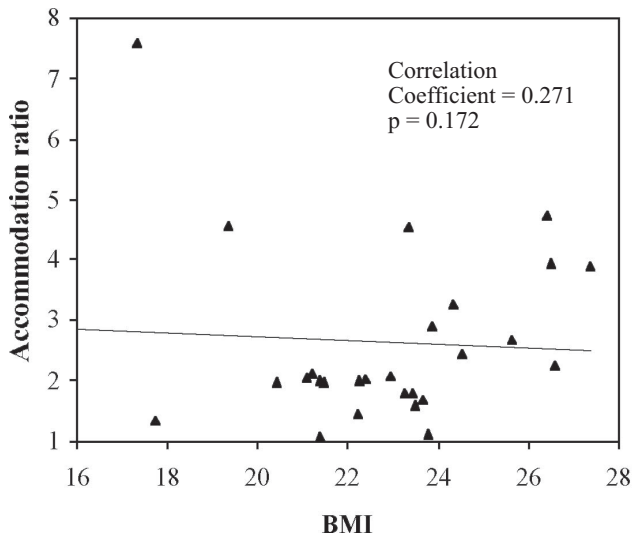


Figure 4 The correlation of gastric accommodation to BMI and age by Spearman correlation coefficient

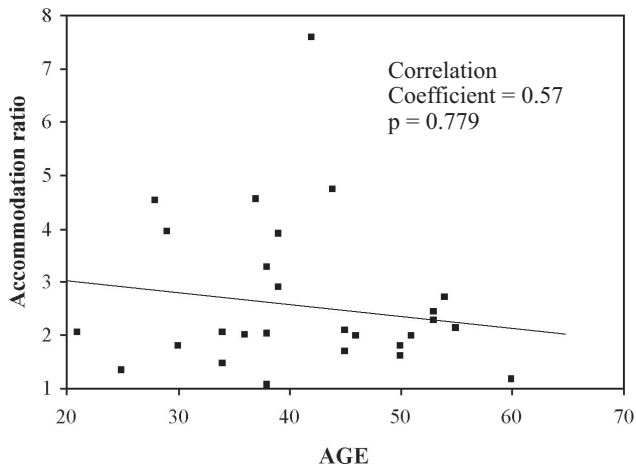


Figure 5 The correlation of accommodation ratio to BMI and age by Spearman correlation coefficient

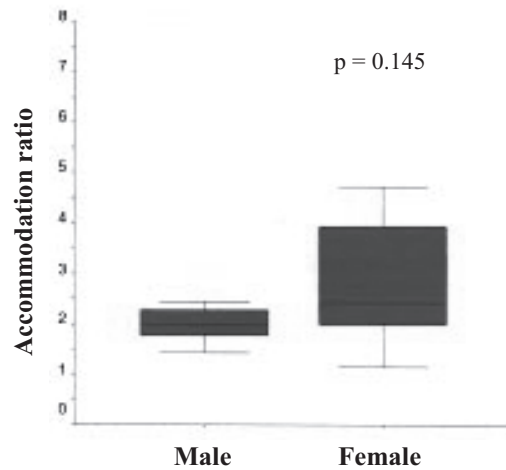


Figure 6 Correlation of accommodation ratio to sex

time post-prandial SPECT scanning and used an average post-prandial gastric volume to be analyzed, but the differences between each value were not shown. Our study performed only one time post-prandial SPECT to limit radiation exposure. Currently, there are no any data mentioned about the dynamic change of gastric volume measured by SPECT scanning. So, further investigation may be required.

Since secondary lactase deficiency is quite common among Thai adults. Therefore, we chose Panenteral[®] as a test meal, because it is lactose free. These was no complication from test meal reported in our study.

All studies of gastric accommodation by SPECT used liquid meal. Solid meal has never been tried. So, there were no data to suggest most appropriate type of test meal for gastric accommodation study.

We believe, this is the first study of gastric accommodation measured by SPECT technique in Thailand. This method is noninvasive and easily performed. The results from this study may be used as a reference for future studies on gastric accommodation in Thailand.

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