Gastric capacity is related to body mass index in obese patients. A study using the water load test

Mejía-Rivas M[1], Remes-Troche JM[3,], Montaño-Loza A[1], Herrera M[2], Valdovinos-Díaz MA[1].

1 Gastroenterology and Surgery Department, Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán", Mexico City, Mexico
2 Digestive Physiology and Motility, Medical and Biological Research Institute, Universidad Veracruzana, Veracruz
3 Clinical Research Department, Faculty of Medicine, Universidad Cristóbal Colón, Veracruz, México

Correspondence: Dr. José María Remes-Troche. Laboratorio de Fisiología Digestiva y Motilidad Gastrointestinal, Instituto de Investigaciones Médico-Biológicas, Universidad Veracruzana. Veracruz, México. Phone number: + (52) 229 2021230. *E-mails:* jose.remes.troche@gmail.com, joremes@uv.mx.

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Abstract

Background: The role of gastrointestinal function in obesity is unknown. Recent studies have shown that satiety in obese patients is influenced by an abnormal gastric capacity.
Aim: An easy and non-invasive tool, the water load test (WLT) was used to evaluate gastric capacity and how it relates to body mass index (BMI) in obese patients.
Methods: The WLT was performed in 32 patients with high BMI and 12 healthy volunteers. Water was ingested at a 15 mL/min rate. The maximal tolerable volume (MTV) was defined as the total ingested volume when patients stopped the test.
Results: A BMI > 30 was significantly associated with higher water consumption (2339 ± 306 mL) compared to controls (1830 ± 240 mL, p = 0.001). The MTV had a positive correlation with BMI (r = 0.68, p = 0.001).
Conclusions: Obese subjects have an increased gastric capacity, as measured with the WLT. This greater drinking capacity has a positive correlation with the subjects' BMI.

Key words: obesity, body mass index, water load test, Mexico.

Resumen

Antecedentes: *El papel de la función gastrointestinal en la obesidad es desconocido. Estudios recientes han mostrado que la saciedad en los obesos está incluida por una capacidad gástrica anormal.*
Propósito: *Evaluar cómo se relaciona la prueba de carga de agua (WLT), herramienta sencilla y no invasiva utilizada para evaluar la capacidad gástrica, con el índice de masa corporal (BMI) en los obesos.*
Métodos: *La WLT fue realizada a 32 pacientes con BMI alto y a 12 voluntarios sanos. El agua fue ingerida a una medida de 15 mL/minuto. El volumen máximo tolerado (MTV) fue definido como el total ingerido en cuanto los pacientes detuvieron la prueba.*
Resultados: *Un BMI > 30, fue asociado significativamente con altos consumos de agua (2339 ± 306 mL) comparado con los controles (1830 ± 240 mL, p = 0.001). El MTV tuvo una correlación positiva con el BMI (r = 068, p = 0.001).*
Conclusiones: Los sujetos obesos tienen una capacidad gástrica incrementada, medida por la WLT. Esta mayor capacidad para ingerir agua, tiene una correlación positiva con el BMI de los pacientes.

Palabras clave: *obesidad, índice de masa corporal, prueba de carga de agua, México.*

Introduction

Obesity is nowadays considered a systemic disorder consequence of an energy intake greater than the energy expenditure, and influenced by several factors such as genetics, environment, behavior and socioeconomics.[1] The role of gastrointestinal tract function in obesity remains largely unknown, but recent studies have shed new light on the underlying pathophysiology.[1-4] For example, it is now known that the stomach sensory function plays a key role in feeding control, and that satiety is determined by gastric motor function, including tone, accommodation and emptying. Gastric motility disorders reported in obese patients include an increased gastric capacity,[3,4] increased postprandial accommodation[5,6] and increased gastric emptying.[7] A better understanding of changes in motor and sensitive gastric functions in obesity is necessary for the development of adequate and new therapeutic options.

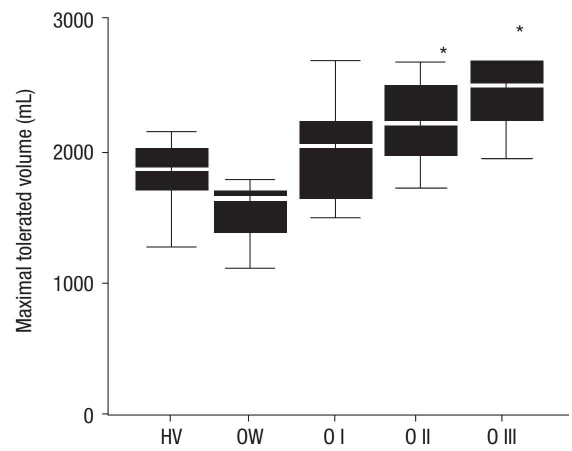
Many techniques such as gastric barostat, ultrasound, SPECT imaging, and gastric emptying scintigraphy have been used to evaluate gastric function. Some of these techniques are invasive and uncomfortable, while others are expensive, not well standardized, highly user dependent, or not widely available. The water load test (WLT) has emerged as a non-invasive, reliable, easy and inexpensive method to evaluate gastric capacity for liquids, and to indirectly evaluate accommodation, sensitivity and gastric emptying.[8]

The aim of the present study was to investigate the relationship between BMI and gastric capacity using a WLT.

Methods

In an experimental and controlled study, 32 consecutive subjects with high BMI (36 ± 8 years of age, 22 females) attending the outpatient Bariatric Surgery Clinic at the *Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán"* (INCMNSZ) in Mexico City were studied. Patients were classified according to their body mass index (BMI) as: *a*) overweight (OW, BMI > 25 kg/m^2 and < 30 kg/m^2) $n = 5$, *b*) grade I obesity (OI, BMI ≥ 30 kg/m^2 and < 35 kg/m^2) $n = 4$, *c*) grade II obesity (OII, BMI ≥ 35 kg/m^2 and < 40 kg/m^2) $n = 7$, *d*) grade III obesity (OIII, BMI ≥ 40 kg/m^2) $n = 16$.[4]

Figure 1.
Maximal tolerated volume during the WLT among groups. * $p = 0.01$, Kruskal-Wallis Test.



Twelve non-obese healthy volunteers (30.5 ± 9 years of age, 10 females) were used as controls. The protocol was approved by the INCMNSZ Institutional Committee for Human Research, and all subjects signed an informed consent.

After an overnight fast of 8 hours, patients arrived at the Motility Unit of the INCMNSZ, an academic, third level, referral center. The WLT was performed by having the subjects drink room-temperature tap water at a predetermined rate of 15 mL/min as reported elsewhere.[8] Severity of dyspeptic symptoms was evaluated every 5 min using a 5-point Likert scale. When either a score of 5 was reached for any of the symptoms, or the subject could not tolerate more volume, the test was stopped and the total ingested volume (mL) was registered. The MTV was defined as the total ingested volume.

Symptoms scores and volumes are expressed as mean ± SD. Comparisons for each group were done using χ^2 and Mann-Whitney tests, when appropriate. For multiple comparisons, the non-parametric Kruskal-Wallis test was used. A p value < 0.05 was considered statistically significant. The Pearson (r) test was used to establish correlations for MTV between WLT and symptom scores.

Results

BMI values were (mean ± SD): 22.3 ± 2 kg/m^2 in HV; 27.8 ±1.74 kg/m^2 in OW; 33.4±1.9 kg/m^2

in OI; 38.2 ± 1.65 kg/m^2 in OII; and 43.3 ± 1.78 kg/m^2 in OIII.

There were no overall differences among groups for age (p = 0.56) and gender (p = 0.78) (data not shown). There were also no differences for MTV according to gender (p = 0.85) (data not shown). Patients with OII and OIII had significantly higher MTV (2089 ± 358 mL and 2339 ± 306 mL) (HV: 1830 ± 240 mL, OW: 1783 ± 286 mL, OI: 2006 ± 510 mL), p = 0.001 (**Figure 1**). Furthermore, MTV had a positive correlation with BMI (r = 0.68, p = 0.001).

Bloating and satiety were the most frequently reported symptoms that made HV and patients with a high BMI stop the WLT test. The severity scores were also similar between HV and obese subjects.

Discussion

Several studies have been recently conducted to evaluate gastric function and its role in the pathogenesis of obesity. In this study, we found that BMI had a positive correlation with greater gastric capacity in obese subjects.

As gastric distention after food ingestion is a key mechanism to induce satiation, it has been suggested that obese subjects have greater food consumption because the volume needed to induce a gastric distention that elicits the feeling of fullness is higher compared to that in controls.[3-6] Using invasive (gastric latex balloon distension) and non-invasive methods (SPECT and nutrient drink test), previous studies have found that obese subjects may have a greater gastric capacity.[6] Our findings are consistent with such studies suggesting that satiation and gastric capacity in obese patients correlate with a higher BMI. However, the causality of this observation requires further investigation.

The maximum ingested volume of a liquid depends on a balance between mechanisms that increase gastric volume (accommodation reflex) and the negative feedback that slows gastric emptying and induces satiety after a meal.[9] The gastric accommodation reflex is elicited both by distension of the stomach and by nutrients in the duodenum. Because water is a non-nutrient stimulus, the WLT primarily tests sensitivity and accommodation to gastric distension and not nutrient-induced alterations (e.g. Nutridrink or other meal tests).[10] One mechanism that could induce satiation and fullness during the WLT is the activation of vago-vagal reflexes resulting in proximal gastric relaxation in response to gastroduodenal distension which in turn stimulates gastric stretch receptors that induce vagal discharges and activates hypothalamic neurons.[8]

Although the WLT has been used to measure gastric sensation and accommodation, we are unable to exclude the possibility that the observed differences in gastric capacity may simply reflect an accelerated gastric emptying in obese subjects. In fact, it has been reported that obese subjects may have an accelerated gastric emptying as a consequence of a rapid intragastric meal distribution to the antrum and, hence, do not require a large proximal portion of stomach to accommodate a meal.[8,10]

In conclusion, we have confirmed that obese patients have increased gastric capacity, as measured by the WLT. Our findings suggest that obese patients have an increased gastric accommodation and a faster gastric emptying or lower satiety thresholds in response to liquid ingestion. These mechanisms may play a key role in developing or maintaining higher food consumption in obesity. Additional studies are needed to clarify the cause-effect between gastrointestinal symptoms and BMI in obese subjects.

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