Effect of Nutritional Rehabilitation on Gastric Motility and Somatization in Adolescents with Anorexia

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Objective To examine gastric function, as well as the presence of somatic complaints, anxiety symptoms, and functional gastrointestinal disorders (FGIDs), in adolescents with anorexia nervosa (AN) before and after nutritional rehabilitation.

Study design Sixteen females with AN and 22 healthy controls with similar demographic profiles were included. Gastric emptying (measured as residual gastric volume) and gastric accommodation (measured as postprandial antral diameter) were assessed with abdominal ultrasonography. Participants completed the Children's Somatization Inventory (CSI), the Screen for Child Anxiety-Related Emotional Disorders, and the *Questionnaire on Pediatric Gastrointestinal Symptoms–Rome III version*. All testing was repeated 3-4 months later.

Results Body mass index in the AN group improved over time ($P = .012$). Fasting gastric parameters were similar in the 2 groups. Maximum postprandial antral diameter was significantly greater in controls compared with the AN group ($P = .008$). Only adolescents with AN demonstrated a significant increase in maximum postprandial diameter at repeat testing ($P = .009$). There was no difference in residual gastric volume between the 2 groups. Initial CSI scores were higher in adolescents with AN ($P < .0001$), including higher scores for nausea and abdominal pain. CSI scores were significantly lower in adolescents with AN ($P = .035$). Initial scores on the Screen for Child Anxiety-Related Emotional Disorders were significantly higher in adolescents with AN ($P = .0005$), but did not change over time. Adolescents with AN met significantly more criteria for FGIDs ($P = .003$).

Conclusion Adolescents with AN have impaired gastric accommodation that improves after nutritional rehabilitation, have significantly more somatic complaints, and meet more criteria for anxiety disorders and FGIDs. After nutritional rehabilitation, somatization improves and FGIDs become less common, but symptoms of anxiety persist. *(J Pediatr 2013;163:867-72)*.

Disordered eating behaviors and weight concerns are common among adolescents. Almost two-thirds of adolescent girls and almost one-third of adolescent boys report trying to lose weight, and almost 50% of adolescent girls use unhealthy measures in an attempt to lose weight.[1] Eating disorders affect more than 11 million people in the US alone. Anorexia nervosa (AN) is the third most common chronic illness in female adolescents and young adults, after obesity and asthma, and carries significant medical, social, psychological, and economic costs.[2-5] AN is a clinical diagnosis characterized by the refusal to maintain body weight at or above a minimally normal level for age and height, as well as an intense fear of gaining weight and a disturbance in body image.[6] Although the etiology and pathogenesis of AN remain unclear, the morbidity and mortality are profound, and the majority of affected patients are diagnosed with comorbid psychiatric disorders.[7,8]

AN is associated with a variety of medical complications, with gastrointestinal disturbances particularly common.[9] Bloating, nausea, abdominal distension, and gastric fullness are reported in as many as 78% of those with AN, and multiple studies in adults with AN have demonstrated delayed gastric emptying.[10-12] Currently, scintigraphy is considered the gold standard for measuring gastric emptying, and the barostat balloon and single photon emission computed tomography testing are used to measure gastric volume and assess gastric accommodation.[13] These methods have several disadvantages, however, particularly in the pediatric population, including exposure to ionizing radiation, the invasive nature of the studies, increased expense, and the need for specialized equipment and training. Ultrasonography offers a safe, well-tolerated alternative to these methods of assessing gastric emptying and gastric volumes,[14-19] and has been validated against the gold standard.[20,21] There is strong evidence indicating that the longer the duration of illness, the more difficult the recovery.[22] This suggests that the

AN	Anorexia nervosa
CSI	Children's Somatization Inventory
FGID	Functional gastrointestinal disorder
QPGS-RIII	*Questionnaire on Pediatric Gastrointestinal Symptoms–Rome III version*
RGV	Residual gastric volume
SCARED	Screen for Child Anxiety-Related Emotional Disorders
T1	Baseline/initial testing
T2	Follow-up testing

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prevention of long-term comorbidity in adolescents with AN through early detection and treatment is possible. Improved understanding of the pathophysiology of gastrointestinal symptoms may be useful in the treatment of adolescents with AN, who are more likely to respond to concrete statements about the effects of malnutrition and poor eating habits on their physical health.[2]

In this prospective controlled study, we sought to examine the differences in gastric motility and accommodation in pediatric patients with AN before and after nutritional rehabilitation, and to examine the differences in self-reporting of somatic complaints, anxiety symptoms, and functional gastrointestinal disorders (FGIDs) between healthy controls and adolescents with AN before and after nutritional rehabilitation.

Methods

The study subjects included female patients with AN aged 10-21 years who met the criteria for medical admission, including severe bradycardia, orthostatic hypotension, electrolyte abnormalities, inability to maintain weight, and hypothermia. Exclusion criteria included a history of gastric surgery, concurrent use of motility agents, past history of diseases associated with gastroparesis (including, but not limited to, diabetes, cystic fibrosis, inflammatory bowel disease, and celiac disease), and inability to complete the questionnaires or provide appropriate consent/assent. Controls were age-matched females recruited from an adolescent primary care clinic and via a mass e-mail sent out to all hospital employees. The control subjects recruited from the clinic had presented for vaccinations or sports physicals. The inclusion and exclusion criteria for the control group were the same as above, with the additional exclusion criteria of a diagnosed FGID and a body mass index <5th percentile or ≥95th percentile.

After appropriate consent and assent were obtained, participants completed questionnaires regarding somatic complaints, symptoms of anxiety, and gastrointestinal symptoms and underwent limited abdominal ultrasonography surrounding a standard liquid meal to obtain gastric measurements including, but not limited to, antral diameter and gastric emptying time (as described in detail below). This baseline/initial testing is termed T1. All analyses were repeated 14 ± 2 weeks later; this follow-up testing is designated T2. The research protocol was approved by the Nationwide Children's Hospital Institutional Review Board.

Weight, height, vital signs, medications, medical and social history, and calorie counts (with the aid of a food diary) were recorded. All ultrasound examinations were completed in the morning after an overnight fast of at least 8 hours. Patients were given a 300-mL liquid meal consisting of a 1-kcal/mL liquid supplement (Ensure; Abbott, Columbus, Ohio). Sonographic measurements (including antral diameter as a measure of gastric accommodation and gastric volumes)[14-17] were obtained just before and immediately after the meal, and then at 10-minute intervals for the next 1 hour. Multiple measurements were taken at each interval. Residual gastric volume (RGV) at the end of the 60-minute measurement period was calculated as a measure of gastric emptying. The personnel performing ultrasonography were blinded to the overall aims of the study, and the radiologist was blinded to the type of patient (AN vs control) at the time of image interpretation. All patients cooperated with ultrasonography without difficulty.

The Children's Somatization Inventory (CSI)[23,24] is a tool developed to better characterize the breadth and severity of somatic symptoms in pediatric patients. The short form is a 19-item scale. The response format is a 5-point Likert scale, with responses ranging from "not at all" (0) to "a whole lot" (4). Symptoms include headaches, abdominal pain, nausea, and bloating. The standard time period for symptom reporting is 2 weeks. Total CSI scores can range from 0 to 76, obtained by summing all item ratings, with higher scores corresponding to increased somatization. The CSI has been validated in patients with recurrent abdominal pain, school children, and healthy patients aged 6-18 years. It has demonstrated good internal consistency and test-retest reliability.

The Screen for Child Anxiety-Related Emotional Disorders (SCARED)[25] is a 41-item self-report questionnaire designed to screen for the presence of anxiety disorders in children and adolescents aged 9-18 years. The response format is a 3-point Likert scale, with responses ranging from "not true or hardly ever true" (0) to "often true or very true" (2). Total SCARED scores can range from 0 to 82, obtained by summing all item ratings, with higher scores corresponding to increased anxiety. The scale has been validated in clinical and community samples, with good internal consistency and good test-retest stability even at 12 weeks.[26]

The *Questionnaire on Pediatric Gastrointestinal Symptoms–Rome III version* (QPGS-RIII)[27] is an adaptation and abbreviation of the *Questionnaire on Pediatric Gastrointestinal Symptoms*. The self-report version of the QPGS-RIII is suitable for administration to children 10 years of age and older. It uses a 5-point scale to measure frequency, severity, and duration of symptoms. In addition, it can be scored to assess whether a patient meets criteria for each of the individual FGIDs. The QPGS-RIII has been validated and has demonstrated good test–retest reliability.

Given a medium effect size, 2 covariates, significance level of 0.05, and power of 0.94, a minimum total sample size of 16 patients (study patients and controls) was required to detect a group difference in both gastric emptying time and gastric antral diameter between T1 and T2. For continuous variables with repeated measurements, we used the mixed procedure for comparisons between groups, with consideration of correlations within subjects. For categorical variables with repeated measurements, we used the GENMOD procedure for logistic regression, with consideration of correlations within subjects. For categorical variables at time period 0 only, we used logistic regression. We examined correlations between gastric emptying and gastric accommodation both before and after nutrition, as well as CSI scores, SCARED scores, and QPGS-RIII scores before and after nutrition, using a paired-sample *t* test and generalized linear model. All