Bacterial Overgrowth and Methane Production in Children with Encopresis

Alycia Leiby, MD, Devendra Mehta, MD, Vani Gopalareddy, MD, Susan Jackson-Walker, PhD, and Karoly Horvath, MD, PhD

Objectives To assess the prevalence of small intestinal bacterial overgrowth (SIBO) and methane production in children with encopresis.
Study design Radiographic fecal impaction (FI) scores were assessed in children with secondary, retentive encopresis and compared with the breath test results. Breath tests with hypoosmotic lactulose solution were performed in both the study patients (n = 50) and gastrointestinal control subjects (n = 39) groups.
Results The FI scores were significantly higher in the patients with encopresis who were methane producers ($P < .01$). SIBO was diagnosed in 21 of 50 (42%) patients with encopresis and 9 of 39 (23%) of control subjects ($P = .06$). Methane was produced in 56% of the patients with encopresis versus 23.1% of the control subjects in the gastrointestinal group ($P < .01$). Fasting methane level was elevated in 48% versus 10.3 %, respectively ($P < .01$).
Conclusions Children with FI and encopresis had a higher prevalence of SIBO, elevated basal methane levels, and higher methane production. Methane production was associated with more severe colonic impaction. Further study is needed to determine whether methane production is a primary or secondary factor in the pathogenesis of SIBO and encopresis. *(J Pediatr 2010;156:766-70)*.

It has been shown that the onset of constipation may be associated with a diet change early in life, toilet training during the toddler years, or a painful defecation episode associated with either anal fissures or an infectious colitis, leading to withholding.[1] Untreated chronic constipation may result in fecal incontinence. Encopresis was the most frequent accompanying symptom (84%) in children presenting with constipation to pediatric gastroenterologists.[2]

Encopresis is frustrating for patients and families and often requires a significant period of time for treatment and bowel retraining. The recovery rates vary from 30% to 50% after 1 year and from 48% to 75% after 5 years of treatment.[3]

Orocecal transit time is prolonged in children with constipation.[4,5] Animal studies have shown that methane, a product of colonic bacterial fermentation in human beings, prolongs intestinal transit.[6] Methane production on breath tests has been associated with prolonged intestinal transit time.[6-8] Soares et al[8] reported that breath methane production is associated with a prolonged colonic transit time in children with constipation. It was also reported that methane production is more common in children with encopresis when compared with children with constipation only and in control subjects.[8,9]

Anaerobic bacteria in the terminal ileum and colon are responsible for the production of methane gas. Elevated pH and increased anaerobic states result in higher methane production in the gut.[10] Up to one third of control subjects exhaled methane[11] over 1 ppm, and there was a negative correlation between frequency of bowel movements and breath methane concentration. Increased breath methane level has been reported in many disorders, including cystic fibrosis, diverticulosis, constipation-predominant irritable bowel syndrome, and colon cancer.[12-15]

In healthy subjects, bacterial proliferation in the upper gastrointestinal tract is controlled by gastric acid secretion, intestinal motility, and the mucosal immune system. Prolonged intestinal transit time represents a risk factor for small intestinal bacterial overgrowth (SIBO). SIBO is defined by an excessive amount of bacteria, particularly anaerobes, in the upper gastrointestinal tract at levels >10^{5-7} organisms/mL.[16] Despite the data on the effect of methane on intestinal transit, there is no published report examining the prevalence of SIBO in children with encopresis. The aim of this study was to assess SIBO prevalence measured by the lactulose breath test in children with secondary, retentive encopresis with and without methane-producing flora and to compare the results with control subjects.

Methods

The study was conducted at the Gastroenterology and Nutrition Outpatient Clinic of the Alfred I. duPont Hospital for Children in Wilmington, DE, from January 2005 to June 2008. The study enrolled otherwise healthy school age children (6 to 12 years) with normal general intellectual functioning who had a history and physical examination consistent with secondary retentive encopresis. All

FI	Fecal impaction
LBT	Lactulose breath test
SIBO	Small intestinal bacterial overgrowth

From the Division of Pediatric Gastroenterology and Nutrition (A.L., D.M., V.G., K.H.) and Division of Behavioral Health (S.J.), Alfred I. duPont Hospital for Children, Wilmington, DE, and the Thomas Jefferson University (A.L., D.M., V.G., S.J., K.H.), Philadelphia, PA

Funding for the project was obtained through the Nemours Foundation. The authors declare no conflicts of interest.

 10.1016/j.jpeds.2009.10.043

patients had daily or weekly episodes of fecal soiling for a minimum of 2 months before evaluation. Patients were not excluded if they had previously been treated for encopresis, because all were still symptomatic and non-adherent to the prescribed therapies. Children with a history of gastrointestinal surgeries, or neuroanatomic disorders were excluded.

Fifty children with encopresis were included in the study, and 68% (34 of 50) were male patients. Mean duration of constipation was 3.47 ± 2.56 years. The control group consisted of 39 children of whom 61% were male. Control patients had various gastrointestinal problems but had no signs or symptoms of constipation or encopresis. The indications for the test included abdominal pain, flatulence, vomiting, and diarrhea. Although there was no significant age difference between the groups, the body mass index (BMI), weight, and height percentiles were significantly higher in the encopresis group (data not shown).

Fecal Impaction Scores

An abdominal flat-plate radiograph was obtained for all the patients with encopresis before the start of therapy. The degree of fecal impaction was assessed by a scoring system ranging from 0 to 3.[17] A grade of "0" was designated for feces in the rectum and cecum only; a grade of "1" for feces in the rectum, cecum, and discontinuous elsewhere; a grade of "2" for feces in the rectum, cecum, and continuous (allowing for gas) and affecting all segments; and a grade of "3" for feces in the rectum, cecum, continuous elsewhere, and a dilated colon and impacted rectum. **Figure 1** (available at www.jpeds.com) shows examples of impaction scores. The radiographs were reviewed at the first office visit and independently by 2 investigators. In cases of discrepancy the score that was in agreement between 2 of the 3 physicians was used.

Lactulose Breath Test

The lactulose breath test (LBT) was performed at the first visit before starting the therapy. To reduce osmotic effect, the test solution consisted of lactulose 10 g in water 240 mL. This solution had an osmolality of 121 mosmol/L.

All patients completed the lactulose breath test after an overnight fast of 10 hours. Patients were given a list of foods high in carbohydrates to avoid the afternoon and evening before the day of testing and were advised to avoid smoke exposure and vigorous exercise on the testing day. Testing was rescheduled if the patient had been on an antibiotic within the previous 2 weeks or had significant carbohydrate consumption the night before.

An initial baseline breath sample was collected. Additional samples were then collected at 15, 30, 45, 60, 90, 120, 150, and 180 minutes after the ingestion of test solution. End-expiratory breath samples were collected with the GaSampler system (QuinTron Instrument Company, Milwaukee, Wisconsin). Two samples were taken at each collection point. The second sample was used if the level of carbon dioxide in the first sample was too low.

Samples were measured with the Microlyzer model SC analyzer (QuinTron Instrument Company). Hydrogen and methane concentrations were expressed in ppm. The machine was calibrated with the QuinGas-3 (QuinTron Instrument Company) standard gas mixture containing 100 ppm hydrogen, 50 ppm methane, and 5% carbon dioxide.

Criteria for Methane Production and SIBO

Patients were considered methane producers if their level was more than 3 ppm at any point in the study (based on ambient air containing about 1.8 ppm).[18] High basal methane was diagnosed if the baseline sample was >10 ppm. SIBO was diagnosed if the hydrogen level was ≥20 ppm or the methane level was ≥10 ppm above baseline at ≤60 minutes.[19]

Ethics

The Nemours Clinical Research Review Committee and Institutional Review Board approved the protocol. Permission for participation was obtained from the guardian and assent for participation from children ages 7 to 12 years.

Statistical Analysis

The χ^2 test for a 2-tailed P value was used for comparing frequencies between 2 groups. Odds ratios and 95% confidence intervals were calculated. For comparing means between the 2 groups, the 2-tailed t test was used. $P < .05$ was considered as statistically significant.

Results

The mean fecal impaction (FI) radiographic score was 1.9 ± 0.65 for the entire encopretic group. There was a significant difference ($P < .01$) in the mean FI score between methane producers (2.03 ± 0.32; n = 24) and non-methane–producing patients (1.72 ± 0.44; n = 26). The mean FI scores of the SIBO-positive patients (1.9 ± 0.49) and the SIBO-negative patients (1.89 ± 0.39) were not different ($P = .06$).

SIBO was found in 21 of the 50 (42%) children with encopresis. The prevalence of SIBO was lower (23.1%) in the gastrointestinal control group. The difference did not reach statistical significance ($P = .06$). Of the patients with encopresis and SIBO, the diagnosis was made on the basis of elevated methane levels in 8 patients, elevated hydrogen levels in 11 patients, and both elevated methane and hydrogen levels in 2 patients. The diagnosis of SIBO is sometimes based on a "double peak," which is defined as an early peak of 2 consecutive hydrogen values more than 10 ppm above the baseline value that is clearly distinguishable from a colonic peak of >20 ppm above baseline[20] or a rise of 20 ppm occurring more than 15 minutes before a colonic peak.[19] In our group, a double peak was found in 10 patients with encopresis and 2 gastrointestinal control subjects. There was no difference between groups in sex or existence of SIBO.

High basal methane concentration was measured in 24 of 50 (48%) patients with encopresis versus 4 of 39 (10.3%) control subjects ($P < .001$). Methane production (≥3 ppm)