Childhood constipation: new insights in testing, treatment and cost
Liem, O.

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Chapter 5

Constipation and colonic transit times in morbidly obese children

Olivia Liem
Olga H. vd Baan-Slootweg
Noor Bekkali
Wim M.C. van Aalderen
Tammo H. Pels Rijcken
Carlo Di Lorenzo
Marc A. Benninga

Submitted
ABSTRACT

Objectives
To determine the prevalence of functional constipation according to the Rome III criteria in children with morbid obesity and to evaluate whether decreased colonic motility is present in these children by measuring colonic transit times (CTT).

Study design
91 morbidly obese children aged 8 -18 years entering a prospective, randomized controlled study evaluating the effect of an outpatient vs. inpatient treatment program of obesity participated. All children filled out a standardized questionnaire regarding their bowel habits and colonic transit times were measured using radio-opaque markers. Food diaries were also recorded to evaluate their diet.

Results
A total of 19 children (21%) had functional constipation according to the Rome III criteria, whereas one child suffered from functional non-retentive fecal incontinence. Of only 10.5% of the children with constipation the total CTT exceeded 62 hours, and among them two had a total CTT of more than 100 hours. In the non-constipated group 8.3% had a delayed CTT. Furthermore, no difference was found between the diet of children with or without constipation, specifically not with respect to fiber intake.

Conclusion
Our study confirms a high prevalence of functional constipation in obese children, using the Rome III criteria. However, abnormal colonic motility, as measured by colonic transit time was only delayed in a minority of patients. Disappointingly, no relation was found between constipation in these children and fiber or fat intake.
INTRODUCTION

Childhood obesity has become one of the rising health concerns worldwide and is associated with a number of co-morbidities. Even at young age being overweight or obese significantly increases the chance of developing serious chronic conditions, such as hypertension, hepatosteatosis and diabetes type II. In addition to these comorbid conditions, functional gastrointestinal disorders have also been linked to obesity. In adults gastroesophageal reflux disease is associated with increasing BMI, as are abdominal pain and bloating. In contrast to studies in adults reporting an increase of diarrhea in obesity, recent studies in children found an increased prevalence of constipation in a group obese children and vice versa; a higher prevalence of obesity in the constipated group. The mechanisms underlying the relationship between obesity and constipation are still unknown and may involve motor and sensory abnormalities.

A non invasive method to assess colonic motility is total and segmental colonic transit time (CTT) measurement using radio-opaque markers. In both adults and children measuring colonic transit time helps to differentiate among different subgroups of patients and it has been suggested that slow transit constipation also affects a significant subgroup of children with disorders of defecation. It is unknown whether delayed colonic transit plays a role in obese children with constipation.

The purpose of this study was to determine the prevalence of functional constipation in morbidly obese children and to evaluate whether delayed colonic motility is present in these children by measuring colonic transit times.

METHODS

Participants were children aged 8-18 years who entered a prospective, randomized controlled study evaluating the effect of an outpatient vs. inpatient treatment of obesity at a specialized obesity clinic (Heideheuvel, Hilversum, the Netherlands) between 2004 and 2007. Inclusion criteria included a body mass index (BMI) for age of 35 and greater, adjusted for age and sex, or a BMI of 30 in the presence of obesity related morbidity. BMI was calculated as weight in kilograms divided by height in meters squared (kg/m²). Age adjustment was performed based on the curves corresponding to adult BMI cut off points of 25 respectively 30, published by Cole et al. To obtain the curve corresponding to an adult BMI of 35, the difference of the distance of the 25 and 30 curves was added to the 30 curve.

Patients were excluded if they had a psychiatric disorder (e.g. schizophrenia, severe autism, or mental retardation) or other serious medical conditions that would preclude participation in the program. Patients taking medication that potentially
cause significant weight gain or medication for weight loss were also excluded as well as participants using medications for weight loss or involved in a coexisting weight management program.

At intake, before any intervention, a standardized questionnaire regarding bowel habits was filled out and a CTT study was performed. A bowel diary was also used for at least 2 weeks documenting bowel movement and fecal incontinence frequency. Functional constipation was defined using Rome III criteria. At least two of the following criteria had to be present for 8 weeks: 1) defecation frequency <3 per week, 2) ≥ 1 fecal incontinence episodes per week, 3) passage of large amounts of stool, 4) presence of fecal impaction, 5) painful or hard defecation, 6) withholding behavior. Physical exam was performed on all children, including a rectal exam in 69 patients.

Food intake was measured using a 7-days dietary record. Subjects received instructions from a dietitian on how to keep a food record and were asked not to change their habitual food intakes. The data of the food records were used to calculate intakes of total daily energy, fat and fiber with a computer program based on food tables (BECEL nutrition program, version 5.05, 1995; Nederlandse Unilever Bedrijven BV, Rotterdam, Netherlands).

All children underwent a CTT study using the method described by Bouchoucha and colleagues. Treatment with oral or rectal laxatives was discontinued for at least one week before the test. They then ingested a capsule containing 10 radio-opaque markers on six consecutive mornings. An abdominal X-ray was obtained on day 7. Localization of markers was based on the identification of bony landmarks and gaseous outlines as described by Arhan and colleagues. Markers were counted in the right, left, and rectosigmoid regions, and mean segmental transit times were calculated according to a previously described formula (colon transit time = sum of markers X 2.4). The normal ranges for total and segmental transit times were based on the upper limits (mean + 2 SD) from a study in healthy children. Based on those data, a CTT of more than 62 hours was considered delayed. The upper limits of the normal range for right colon, left colon, and rectosigmoid transit time were 18, 20, and 34 hours, respectively.

The study protocol was approved by the medical ethical committee of the Academic Medical Centre in Amsterdam, the Netherlands. Written informed consent was obtained from the parents or guardians of the children participating and assent from all children 12 years and older.
Statistical analysis

Statistical analysis of the data was conducted using the statistical software package SPSS (version 14.0; Inc, Chicago, IL). Baseline characteristics of the cohort were analyzed in a descriptive way. Median values and ranges were used if the distribution of continuous variables was skewed. Non-parametric (Mann-Whitney U and Kruskal-Wallis) and Chi-square or Fisher’s exact statistics were used to test for differences between groups. A p-value < 0.05 was considered significant.

RESULTS

A total of 91 consecutive morbidly obese children (34% boys) completed our standardized questionnaire and underwent a CTT study. The median age at intake was 15 years (8-18 yrs) and all children had an corrected BMI over 35 kg/m² or 30 kg/ m² with a co-morbidity. Overall, 19 children (21%) fulfilled the Rome III criteria for functional constipation. Of those children, 4 patients were already using laxatives. Seven other children did not fulfill the Rome III criteria at intake but had received laxatives in the past.

Constipated children vs. non-constipated children

The demographic and bowel habit characteristics of the constipated and non constipated children are described in Table 1. Children with constipation were younger (14.0 vs. 15.5, p=0.02) than children without constipation. No difference

| Table 1. Demographics and bowel habit characteristics in 91 morbid obese children |
|---------------------------------|----------------------|
|                                | Constipated | Non constipated |
| N                               | 19          | 72              |
| Male sex                        | 10 (53%)    | 21 (29%)        |
| Median age (yrs) *              | 14.0 (8.0-17.0) | 15.5 (8.5-18.0) |
| Def frequency (per week)        | 7 (1-14)    | 7 (3-21)        |
| Def frequency <3/week           | 1 (5.3%)    | 0               |
| Fecal incontinence *            | 4 (21%)     | 1 (1%)          |
| Passage of large stools         | 11 (58%)    | 24 (34%)        |
| Presence of fecal impaction *   | 2 (11%)     | 0               |
| Hard defecation *               | 9 (47%)     | 0               |
| Painful defecation *            | 4(21%)      | 0               |
| Withholding behavior *          | 12 (67%)    | 9 (13%)         |
| Abdominal pain                  | 11 (58%)    | 30 (30%)        |

* p < .05
was found in gender between children with or without constipation. The median weekly frequency of bowel movements at presentation was 7 times per week (1-14 vs. 3-21, \(p=0.07\) for constipation and no constipation, respectively). Children with constipation had significantly more episodes of fecal incontinence, presence of fecal impaction, hard and/or painful defecation and showed more withholding behavior. Only one child suffered from fecal incontinence without any symptoms of constipation and thus fulfilled the criteria for functional non-retentive fecal incontinence. In line with the latter diagnosis we found a normal CTT in this child.

**Colonic transit time (CTT)**

Table 2 shows the total and segmental colonic transit times at entry of the study. Both groups of children had a total CTT of 26.4 hrs. Prolonged total CTT, exceeding 62 hours, was found in 11% of the children with constipation and among them 2 had a total CTT of more than 100 hours. In the non-constipated group 8% had a delayed CTT. No difference was found in the rectosigmoid transit times between constipated and non-constipated children. The children who ever had laxative treatment (\(n=7\)) or still had laxative treatment (\(n=4\)) tended to have a longer total CTT with a difference that approached statistically significance (\(p=0.056\)). Prolonged total CTT was more frequent in the children who had used laxative (36% vs 5%, \(p<0.01\)).

<table>
<thead>
<tr>
<th>Transit time (hrs)</th>
<th>Children with constipation ((n= 19))</th>
<th>Children without constipation ((n= 72))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total colon</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>26.4</td>
<td>26.4</td>
</tr>
<tr>
<td>Percentiles 25-75</td>
<td>14.4 – 52.8</td>
<td>12.0 – 40.2</td>
</tr>
<tr>
<td>Delayed&gt;62 hrs</td>
<td>10.5%</td>
<td>8.3%</td>
</tr>
<tr>
<td><strong>Ascending colon</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>4.8</td>
<td>2.4</td>
</tr>
<tr>
<td>Percentiles 25-75</td>
<td>0 – 12.0</td>
<td>2.4 – 9.6</td>
</tr>
<tr>
<td>Delayed&gt;18 hrs</td>
<td>5.3%</td>
<td>5.6%</td>
</tr>
<tr>
<td><strong>Descending colon</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>2.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Percentiles 25-75</td>
<td>0 – 7.2</td>
<td>0 – 9.0</td>
</tr>
<tr>
<td>Delayed&gt;20 hrs</td>
<td>15.8%</td>
<td>9.7%</td>
</tr>
<tr>
<td><strong>Rectosigmoid</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>16.8</td>
<td>14.4</td>
</tr>
<tr>
<td>Percentiles 25-75</td>
<td>4.8 – 38</td>
<td>4.8 – 25.8</td>
</tr>
<tr>
<td>Delayed&gt;34 hrs</td>
<td>26.3%</td>
<td>17.7%</td>
</tr>
</tbody>
</table>
Diet
A total of 68 children (75%) completed the food diary. There was no difference in median caloric intake between children with and without constipation (1452 vs. 1628 kcal/day, p=0.129). Fifty-five percent of the children were consuming more than 30% of their total calories as fat. There was no difference in fat intake between children with and without constipation (30% vs. 32%, p = 0.128). Fiber intake was below the minimum daily recommended quantity (age + 5 gram) in 74% of all children. Children with constipation had a median fiber intake of 66% (range 20 – 147) of the recommended amount and children without constipation consumed 77% (range 25 – 166). This difference was not statistically significant (p = 0.42). Overall, 63% of children with constipation had fiber intake lower than recommended compared to 53% of the children without constipation (p = 0.88).

DISCUSSION
This prospective study reports a prevalence of 21% of constipation in morbidly obese children according to the Rome III criteria. This is significantly higher than the prevalence of 8.9% found in children worldwide. 16 The increased prevalence could not be explained by delayed colonic transit which was present in only 8.8% of all children and 10.5% of the constipated children.

Our prevalence rate, using the Rome III criteria, concurs with previous observations made by Fishman et al, who described a prevalence of constipation in 23 % in their group of obese children. 7 Furthermore, fecal incontinence was present in 21% of our patients whereas Fishman et al found that 33% of their patients had fecal incontinence. In contrast to their findings of 7.5%, we only found 1 patient fulfilling the Rome III criteria for functional non-retentive fecal incontinence (FNRFI) which is in agreement with the prevalence rate described in population-based studies (1-4%). 17-19 Infrequent painful defecation and fecal incontinence are the major clinical features present in respectively 49% and 84%, of constipated children. 20, 21 In our study, however, only one child in the constipated group had a defecation frequency less than three times a week. Similarly, fecal incontinence as result of severe fecal impaction was present in only 20% of the constipated children. In a Brazilian population-based study the prevalence of constipation was 29%. In that study constipation was defined as defecation of scybalous stools and/or straining / pain during defecation. 22 The majority of those school children had scybalous stools (66%) and/or painful defecation (38%) whereas only 31% of had fecal incontinence. No data are available on accurate information on stool frequency in this group. We hypothesize that the
low prevalence of fecal incontinence in our study and the Brazilian study compared to the prevalence found in most studies evaluating constipated children could be explained by the different severity of symptoms. Obese children might not seek medical attention for their defecation problems due to embarrassment. This is illustrated in our study by the fact that only 4 out of the 19 children, who fulfilled the criteria for constipation, were already using laxatives. The children previously using laxatives might have had more severe symptoms as shown by the higher proportion of children with a prolonged total CTT in that subgroup. Thus, a lower prevalence of fecal incontinence can be expected when compared to a cohort study describing constipated children with constipation as major complaint.

Our study was not able to explain the high prevalence of constipation by the presence of decreased colonic motility in these children. Only 11% of the constipated children had a prolonged CTT of more than 62 hours. In earlier studies in children with constipation, CTT was delayed in approximately 50% of children. In such studies a low defecation frequency, a high number of fecal incontinence episodes in combination with palpable stools in the rectum correlated well with prolonged total CTT and especially rectosigmoid transit time (RSTT). The normal CTT findings found in the majority of obese patients concur with the mild symptoms of constipation found in this study.

Diet as a reason why obese children are more constipated comes to mind when trying to find other hypotheses. Especially dietary fiber intake was of interest since it has been described that whole grain consumption is inversely related to BMI in adults. The role of dietary fiber in childhood obesity, however, is not known and conflicting reports exist about the role of fiber in childhood constipation. While some studies find comparable intakes between groups, others find that constipated children have a lower intake compared to non-constipated children. Data on the effect of fibers on CTT are also inconsistent. Castilljo et al. showed a decrease in total CTT after treatment with fibers in constipated children, especially in those with prolonged CTT at intake. A study in neurologically impaired children with constipation, however, did not show a change in total CTT after fiber supplementation. These contradictory results have been described in studies in adults as well. Our study showed that the majority of children did not consume the minimum recommended dietary fiber. But McClung et al found that even in health-conscious families, approximately half of the children whom all did not have symptoms of constipation, did not receive the recommended daily grams of fiber. In our study the children with constipation tended to have a lower fiber intake but this was not statistically significant.

No difference in fat intake, another important element of a diet that can influence motility, was found as well. Previously it has been shown that meals containing fat delay gastric emptying and small bowel transit. Using colonic manometry predominately fat containing meals showed to induce more simultaneous and
retrograde contractions that might delay stool transit. No colonic transit time studies have been done to look at this phenomenon.

In conclusion, our study confirms that there is a higher prevalence of childhood constipation in obese children using the Rome III criteria. We showed that the increased prevalence was not due to decreased colonic motility, since no correlation was found between BMI and colonic transit times. The difference in prevalence could also not be explained by differences in the diet, especially not in fiber or fat intake. Therefore other studies are needed to elucidate the relationship between constipation and obesity in children as other factors such as hormones and exercise may also play a role.

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