Brazilian Journal of Medical and Biological Research (2001) 34: 1147-1153
ISSN 0100-879X

Dietary fiber intake, stool frequency and colonic transit time in chronic functional constipation in children

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Abstract

The objective of the present study was to evaluate associations between fiber intake, colonic transit time and stool frequency. Thirty-eight patients aged 4 to 14 years were submitted to alimentary evaluation and to measurement of colonic transit time. The median fiber intake of the total sample was age + 10.3 g/day. Only 18.4% of the subjects presented a daily dietary fiber intake below the levels recommended by the American Health Foundation. In this group, the median left colonic transit time was shorter than in the group with higher dietary fiber intake (11 *vs* 17 h, P = 0.067). The correlation between stool frequency and colonic transit time was negative and weak for left colon (r = -0.3, P = 0.04), and negative and moderate for rectosigmoid and total colon (r = -0.5, P<0.001 and r = -0.5, P<0.001, respectively). The stool frequency was lower in the group with slow transit time (0.8 *vs* 2.3 per week, P = 0.014). In conclusion, most patients with chronic functional constipation had adequate dietary fiber intake. The negative correlation between stool frequency and colonic transit time increased progressively from proximal segments to distal segments of the colon. Patients with normal and prolonged colonic transit time differ in terms of stool frequency.

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Research partially supported by FAPEMIG. F.J. Penna is the recipient of a CNPq fellowship.

Received July 25, 2000
Accepted May 29, 2001

Key words
• Children
• Constipation
• Dietary fiber
• Colonic transit time

Introduction

Intestinal constipation should be understood as a clinical symptom, which may be indicative of many diseases (1). It represents a common problem among children, with estimated frequencies of 0.3 to 8% in the pediatric population (2). A 28% prevalence among school children has been reported in Brazil (3). Stool frequency may be normal in constipated patients (4) who may present normal or prolonged transit time in the colon and/or rectosigmoid (5-7). In general, increased intake of dietary fiber is recommended as treatment for functional constipation of adults and children (2,8,9). It is not clear whether the fiber content of the diet is a determinant factor contributing to the onset and evolution of constipation in all adult and pediatric patient groups, characterized by different patterns of colonic transit time.

The objective of the present study was to determine the possible existence of associations between diet fiber intake, colonic transit time and stool frequency in patients with constipation and whether the fiber intake of

constipated patients was below the level recommended by the American Health Foundation (AHF).

Patients and Methods

Thirty-eight children with chronic functional constipation aged 4 to 14 years were admitted consecutively to the pediatric outpatient clinic of a teaching hospital (Department of Pediatrics, University Hospital, UFMG). The children were submitted to a 24-h dietary recall and 31 of them also kept a 5-day dietary record.

Patients were considered to be constipated when they reported elimination of hardened feces with effort and/or stool frequency of less than three per week and/or abdominal pain with the detection of a fecal mass upon abdominal or rectal examination and/or the presence of a large quantity of feces retained for more than 6 months revealed by abdominal radiography. Patients with encopresis or soiling were only considered when these symptoms were associated with constipation (as defined above) or a report of periodic elimination of very bulky feces.

Soiling and encopresis were defined as involuntary elimination of any amounts of feces into the underwear.

The following inclusion criteria were established: age of 4 to 14 years, complaints compatible with constipation, absence of ongoing treatment for constipation or unsuccessful ongoing treatment, no use of laxatives, no signs or symptoms of organic disease causing constipation, including Hirschsprung's disease, and not having been submitted to abdominal or anorectal surgery.

Anorectal manometry was performed in 37 patients and the presence of an inhibitory anal reflex was demonstrated in all of them. One patient refused the examination.

All patients were submitted to total and segmental colonic transit time determination according to the methods of Chaussade et al. (10) and Metcalf et al. (11). Patients who presented a palpable fecal mass upon abdominal or rectal examination were submitted to fecal disimpaction using glycerin enemas for up to 7 consecutive days before colonic transit time evaluation. A bolus of 20 radiopaque markers was ingested for 3 consecutive days after breakfast or lunch. Simple abdominal radiography was performed on the 4th day and repeated on the 7th and 10th day when the last one revealed marker retention. Radiopaque markers consisted of cylindrical polyethylene structures impregnated with barium at the 20% proportion. The structures measured 6.0 mm in diameter, were 2.0 mm thick, weighed 55.0 mg, and their specific density was 1.05 according to Hinton et al. (12). The colonic regions were determined as described by Arhan et al. (13). Air shadows were also used for the determination of the colonic segments. The reference values obtained by Arhan et al. (13) were adopted. Therefore, the normal upper limit for transit time was considered to be 18 h in the right colon, 20 h in the left colon, 34 h in the rectosigmoid, and 62 h in the total colon. Patients were classified as having normal colonic transit time when transit time through the right and left colon, rectosigmoid and total colon was normal (1) and as having prolonged colonic transit time when transit was above reference values for the total colon or for any colonic segment. Three independent examiners agreed on the evaluations of the radiographs, and only one evaluation was used in this study.

Simultaneously to the evaluation of colonic transit time, dietary evaluation was performed, always by the same nutritionist, who had been trained in the techniques of 24-h dietary recall and food recording applied to children. The children themselves and the persons responsible for them gave information about the preceding day's ingestion (always a weekday) and were instructed on how to fill out the food records (5 recorded days). The nutritionist verified the

records in the presence of the patient and the person responsible. For the 5-day record, two weekdays and one weekend day were considered and the 2 most atypical days were not considered. Objects for home measurements were shown to the patients and persons responsible in order to identify those that most resembled objects of their domestic use. Experimental cooking was performed with these models. A second nutritionist calculated daily ingestion. A computer program was used for the analysis of food records and dietary recall data. A Brazilian table (14) was used in order to determine the calorie and dietary fiber content of foods. Data concerning dietary fiber ingestion are reported as g/day, g/1000 dietary calories, g/kg and grams exceeding patient age.

The Ethics Committee of the institution approved the study and verbal and written informed consent to participate in the study was obtained from all persons responsible for the children.

Statistical analysis

Data were analyzed statistically using the Epi Info software, version 6.03. The correlation between continuous variables was analyzed by the Spearman correlation coefficient. The Kruskal-Wallis test was used for median comparison. Proportions were compared by the chi-square test. The cut-off point for frequency of defecation was set at 0.8 times/week, which was the median for the prolonged transit time group. The most severely constipated subgroup in the total sample was characterized as follows: prolonged transit time and frequency of defecation of less than 0.8 times/week. This subgroup was compared to the remainder of the sample in terms of daily dietary fiber ingestion using the Kruskal-Wallis test. The cut-off point was established at the minimum dietary fiber ingestion recommended by the AHF (age + 5 g/day) (15). The level of significance was set at 5%.

Results

The study population's median age was 7.5 years, with a mean ± SEM of 7.2 ± 0.3 years. The series consisted of 13 girls (34.2%) and 25 boys (65.8%). Mean stool frequency was 1.9 ± 0.2 times/week, and the median 1.8 times/week.

Daily dietary fiber ingestion was determined by two methods and compared for the 31 patients for whom both data sets were available. The mean ± SD values obtained for the 3-day dietary record and the 24-h recall were 20.9 ± 10.7 g and 23.6 ± 11.8 g, and the medians were 19.3 and 23.5 g, respectively, with no significant difference between them (P = 0.23). In the subsequent analysis, data from the 3-day dietary record were used (when the 3-day record was not available the 24-h recall was used). Data concerning daily calorie and dietary fiber ingestion are presented in Table 1. Right colon, left colon, rectosigmoid and total colon transit time was (mean ± SEM) 7.0 ± 1.6 h (median, 3.6 h), 22.0 ± 4.2 h (median, 15.0 h), 38.8 ± 6.1 h (median, 28.8 h), and 68.1 ± 8.8 h (median, 57.0 h), respectively. The Spearman correlation coefficient between stool frequency and fiber intake (in gram fiber exceeding the patient's age) was r = -0.214 (P = 0.197), demonstrating the absence of correlation between variables.

Spearman correlation between stool frequency and transit time showed r = -0.067 and P = 0.650 in the right colon, r = -0.303

Table 1. Daily calorie and dietary fiber intake of 38 patients with chronic functional constipation.

Dietary evaluation	Median	Mean ± SD
Calories per day	1683.1	1694.4 ± 351.4
Gram fiber per day	16.8	19.7 ± 10.2
Gram fiber/1000 dietary calories	10.2	11.4 ± 4.7
Gram fiber/kg	0.77	0.81 ± 0.42
Gram fiber exceeding age	10.3	12.3 ± 10.3

and P = 0.041 in the left colon, r = -0.510 and P<0.001 in the rectosigmoid, and r = -0.507 and P<0.001 in the total colon. Therefore, a weak and negative correlation was observed for the left colon, and a moderate negative correlation for the rectosigmoid and total colon. No correlation was found for the right colon. Figure 1 illustrates the analysis.

No correlation was observed between dietary fiber intake and transit time in each colonic segment (r = 0.221, P = 0.182 for the right colon; r = 0.179, P = 0.282 for the left colon; r = 0.071, P = 0.674 for the rectosigmoid, and r = 0.142, P = 0.393 for total colon).

Based on colonic transit time, patients were divided into two groups, i.e., normal (N = 16) and prolonged (N = 22). Comparison of stool frequency and daily dietary fiber intake between groups is shown in Table 2. The group with prolonged transit time had a significantly lower stool frequency than the group with normal colonic transit time. No association was found between these groups and fiber intake.

The cut-off point for dietary fiber intake was established at AHF's recommended minimum level (age + 5 g) (15). Seven pa-

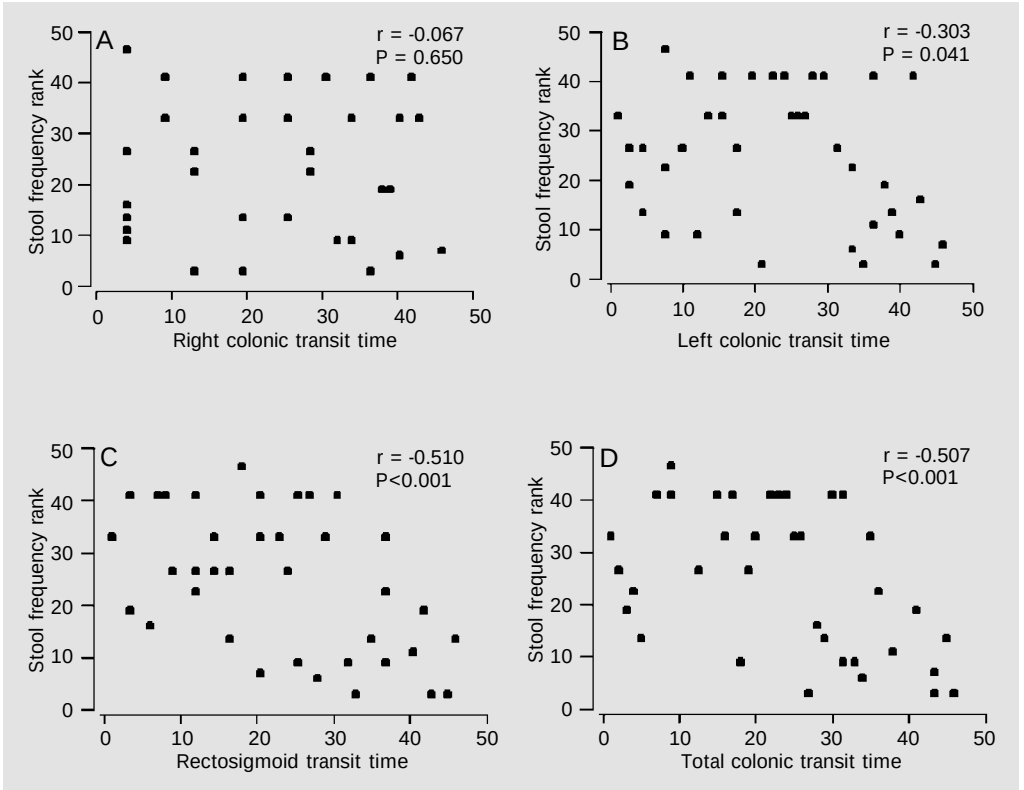

Figure 1. Correlation between stool frequency and right (A), left (B), rectosigmoid (C) and total colonic (D) transit time.

Table 2. Associations between stool frequency, daily dietary fiber intake and colonic transit time patterns.

Colonic transit time	Stool frequency (times/week)			Daily dietary fiber intake (gram fiber exceeding patient age)		
	Median	Mean ± SD	P	Median	Mean ± SD	P
Normal (N = 16)	2.3	2.4 ± 1.5	0.016	10.3	10.3 ± 9.7	0.39
Prolonged (N = 22)	0.8	1.4 ± 1.3		11.0	13.9 ± 10.7	

tients (18.4%) from the total sample, 4 (25%) patients from the normal group, and 3 (13.6%) patients from the slow transit group had an intake below recommended levels (P = 0.425).

The patients were divided into two groups according to stool frequency: under 0.8 times/week (N = 12) and over 0.8 times/week (N = 26). Comparison of daily dietary fiber intake between these groups revealed a mean of 16.2 ± 3.17 g (median, 13.8 g) for the low stool frequency group, and a mean of 11.3 ± 1.76 g (median, 10.2 g) (P = 0.21) for the high stool frequency group. One patient (8.3%) from the under 0.8 times/week stool frequency group and 6 (23%) patients from the over 0.8 times/week stool frequency group had a fiber intake below the recommended level (P = 0.395).

Patients with fiber intake below recommended levels were compared to those with an intake equal to or above the recommended level (Table 3) in terms of colonic transit time. Patients with an intake below recommended levels had a shorter right, left and total colonic transit time than those with a fiber intake equal to or above recommendation. The difference in left colon transit time between groups was close to statistical significance (P = 0.067).

Discussion

Currently, the techniques for diet evaluation most used in clinical practice and in epidemiological surveys are the 24-h recall and the 3-day record, the latter being considered the gold standard (16,17). In the present study, 38 patients performed the 24-h dietary recall and 31 of these also kept a 5-day dietary record (the 2 most atypical days were not considered). Comparison between these techniques revealed no significant differences. Thus, data concerning the 3-day dietary records were preferentially used in the analyses and when they were not available recall data were used. In order to compare groups, dietary fiber intake was expressed using the AHF recommendations for children which are based on patient age (age + 5 g to age + 10 g). These recommendations have been considered adequate and safe for both children and adolescents (15). Few authors have determined colonic transit time in non-constipated control children. Due to the larger size of their sample and the similarities between the age range of their subjects and those reported in the present study, we adopted the reference values obtained by Arhan et al. (13) although they used a single dose of markers. A strong correlation exists between single and multiple marker dose methods in patients with constipation (11).

Lower fiber intake has been reported for constipated children compared to non-constipated children (18,19), whereas among adolescents Zaslavsky et al. (20) did not detect differences in fiber intake between constipated and non-constipated subjects. The median daily fiber ingestion of our sample was not lower than the levels recommended by the AHF (15). Only 7 of our patients (18.4%) ingested lower amounts than those recommended. Few studies have determined the associations between stool frequency, fiber intake and colonic transit time in children. Better clinical results have been reported among constipated adults with normal colonic and total gastrointestinal transit times (21). Preston and Lennard-Jones (22) demonstrated that women with slow transit

Table 3. Total and segmental colonic transit time (hours) in patients with dietary fiber intake below or equal to or above the levels recommended by the American Health Foundation.

Colonic segment	Below recommended level (N = 7)		Above recommended level (N = 31)		P
	Median	Mean ± SD	Median	Mean ± SD	
Right colon	2.4	2.6 ± 2.5	4.8	8.2 ± 10.7	0.080
Left colon	11.0	10.0 ± 9.7	17.0	25.0 ± 27.8	0.067
Rectosigmoid	30.0	26.2 ± 17.7	27.6	41.7 ± 40.2	0.418
Total colon	31.2	38.7 ± 26.4	60.0	74.8 ± 57.0	0.114

do not respond well to dietary fiber supplementation. The present results seem to indicate that groups of patients may exist in the pediatric population in which low fiber intake is not associated with the installed constipation. No statements can be made regarding fiber in relation to the onset of constipation status. Patients with fiber intakes equal to or above recommended levels tend to have slower left colon transit time. Does higher fiber intake intensify constipation in some patients or do patients with severe constipation ingest a larger quantity of fiber in an attempt to resolve constipation? If the second hypothesis is true, the increase in fiber intake does not seem to be solving the problem.

No correlation was detected between dietary fiber intake and segmental colonic transit time. To date, no study has been conducted comparing dietary fiber intake between children with severe constipation and children with less severe types of the condition. In the present study, fiber intake by the normal transit time group was lower than by the group with slow transit time. Evidence that 25% of the children with normal transit time ingested lower than recommended dietary fiber amounts suggests that this factor may be related to less severe types of constipation. This suggestion is due to the fact that the proportion of patients in the prolonged transit time group was smaller (13.6% patients only), although the noted differences were not significant. Again, no correlation was shown between dietary fiber intake and stool frequency. However, when the subgroup with the most severe constipation (slow transit time, stool frequency below the median for the group, 0.8 times/week) was evaluated, a higher intake of dietary fiber was observed, although the difference was not statistically significant.

The correlation between stool frequency and colonic transit time has been reported to be nonsignificant in some studies on adults and children with constipation (11,23,24). However, Bouchoucha et al. (25) demonstrated that the stool frequency of adults without constipation was affected by rectosigmoid transit time. Corazziari et al. (5) demonstrated a significant correlation between stool frequency and prolonged total gastrointestinal transit time in healthy and constipated children. A negative correlation between stool frequency and transit time was observed in the present study and increased progressively in intensity in more distal segments, the correlation being most intense with rectosigmoid transit time. Stool frequency is influenced by defecation control mechanisms, among other factors. The intense correlation with rectosigmoid transit time seems to be due to the fact that transit time in this segment is influenced by the same mechanisms.

Benninga et al. (6) found no significant differences in defecation frequency between constipated pediatric patients with a colonic transit time of over 100 h and under 100 h, the same occurring when patients with total colonic transit time under 63 h were compared to those with colonic transit time under 63-100 h. In the present study, a statistically significant difference in stool frequency was observed between patients with normal transit time and patients with slow transit time.

Patients with prolonged transit time differed from those with normal transit time regarding stool frequency, presenting a lower frequency. Stool frequency is influenced by distal colon segment transit time, particularly rectosigmoid transit time. There is no correlation between stool frequency and dietary fiber intake in children with installed functional chronic constipation. Constipated patient groups with high fiber intake tend to have more severe forms of constipation and prolonged left colon transit time.

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