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Pureed by Gastrostomy Tube Diet Improves Gagging and Retching in Children With Fundoplication

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Background: Children with feeding disorders requiring Nissen fundoplication may develop gagging and retching following gastrostomy feedings. We developed a "pureed by gastrostomy tube" (PBGT) diet in an attempt to treat these symptoms and provide adequate nutrition and hydration. **Methods:** Children post-fundoplication surgery with symptoms of gagging and retching with gastrostomy feedings were selected from our interdisciplinary feeding team. An individualized PBGT diet was designed to meet the child's nutrition goals. The child's weight gain was recorded at each follow-up visit. A telephone survey was performed to determine parents' perceptions of the child's symptoms and oral feeding tolerance. **Results:** Thirty-three children (mean age, 34.2 months) participated in the trial. Average weight gain on the PBGT diet

was 6.2 g/d. Seventeen children (52%) were reported to have a 76%–100% reduction in gagging and retching. Twenty-four children (73%) were reported to have a $\geq 50\%$ decrease in symptoms. No child had worsened symptoms on the PBGT diet. Nineteen children (57%) were reported to have an increase in oral intake on the PBGT diet. **Conclusions:** A PBGT diet is an effective means of providing nutrition to children with feeding disorders. In children post-fundoplication surgery, a PBGT diet may decrease gagging and retching behaviors. (*JPEN J Parenter Enteral Nutr.* 2011;35:375-379)

Keywords: gagging; retching; fundoplication; pureed; diet; gastrostomy tube

Clinical Relevancy Statement

This paper describes the use of a pureed diet given directly into the gastrostomy tube (G-tube) for children with gagging and retching after fundoplication surgery. Children on this diet not only had decreased symptoms, but a proportion also made progress in advancing their oral intake. This pureed by G-tube (PBGT) diet may be useful in children with similar symptoms or as an alternative to formula feedings.

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Introduction

In children with feeding disorders, gastrostomy tube (G-tube) feeding is sometimes unavoidable.^{1,2} Many of these children, particularly those with developmental delays, also undergo Nissen fundoplication surgery to reduce the risk of aspiration or prevent severe gastroesophageal reflux disease (GERD).²⁻⁴

The complications of fundoplications have been well documented, including worsening of feeding problems, dumping syndrome, gas-bloat syndrome, loss of gastric accommodation, and abnormal gastric motility.^{3,5,6} The underlying pathogenesis of these complications is probably multifactorial and has not been well studied. Mechanisms suggested include unrecognized preexisting esophageal or gastric dysmotility, injury caused by inadvertent vagal nerve trauma, and loss fundic accommodation reflex.⁵

Children with a combination of fundoplication and G-tube may develop symptoms such as gagging and retching during or immediately following tube feedings.^{2,3} Parents and caregivers often perceive their child to be in a great deal of distress during these episodes. The symptoms of gagging and retching may affect the child's willingness to accept oral feedings because the child may develop an

additional oral aversion. Persistent gagging and retching may cause the fundoplication to either become undone or create a paraesophageal hernia, leading to GERD or surgical revision.⁵

Several strategies have been tried in an attempt to lessen the gagging and retching associated with G-tube feedings in these children, including frequent venting of the stomach, slowing the rate of tube feeding, or starting the child on a continuous feeding rate.^{5,7} The formula may also be changed to one with a higher fat content, or where dumping syndrome has been confirmed, cornstarch may be added to slow gastric emptying.⁸ In some instances, a gastrojejunal tube is used so that feedings bypass the stomach and are given at a continuous rate into the jejunum.⁹ If the fundoplication is determined to be tight, attempts may also be made to dilate the fundoplication site to allow the stomach to vent more easily and improve dysphagia.¹⁰

These strategies are not always successful, and postprandial gagging and retching may continue. Persistent symptoms can affect both the child and the family's quality of life. The inability to tolerate bolus feedings can require a child to receive continuous feedings for several hours per day, thus restricting his ability to travel or move around unencumbered by a feeding pump and tubing. In addition, specialty formulas are expensive and may be difficult to obtain.

In response to these frustrations, members of our interdisciplinary feeding team at Cincinnati Children's Hospital Medical Center (CCHMC) trialed the use of pureed foods given directly into the G-tube in patients who had experienced gagging and retching post-fundoplication surgery. Pureed or "blenderized" feeds have been described in the literature as an alternative to formula, but their effects have not been well studied.¹¹⁻¹³ We believed that pureed foods might affect stomach emptying and therefore be better tolerated. In this article, we discuss our preliminary results of using a pureed by gastrostomy tube (PBGT) diet in children with gagging and retching post-fundoplication surgery.

Methods

Patients

Children who were followed by the interdisciplinary feeding team at CCHMC and presented with symptoms of gagging and retching after fundoplication surgery were started on a PBGT diet during the time period from January 2003 to November 2006. Patient records were retrospectively reviewed with approval from the CCHMC Institutional Review Board.

Diet

The decision to trial a PBGT diet was determined by the physician, dietitian, and family, based on the child's symptoms. All families were offered the choice of continuing their current diet, trying an alternative formula, modifying

Table 1. Sample Ingredients for a Pureed by Gastrostomy Tube Diet

Diet	5 oz strained meats 8 oz strained plums or bananas 4 oz strained pairs or applesauce 4 oz strained squash or sweet potatoes 6 tbsp infant cereal 1 tbsp oil 4 oz yogurt 3 tbsp cornstarch or sugar 60 mL commercial formula or milk
Total volume	25 oz (750 mL)
Feeding regimen	
Calorie content	942 kcal 30% kcal from fat 55% kcal from carbohydrate 15% kcal from protein 65% free water content

the feeding rate, trialing jejunal feedings, or using the PBGT diet. With the help of a computer program, the Food Processor Program (ESHA Research, Salem, OR), the team dietitian created an individualized PBGT diet formulated to meet each individual child's nutrition and fluid goals. (Table 1). Families primarily used commercially prepared baby food or formula as the base of the diet for ease of preparation and consistency of nutrients. Parents were instructed to refrigerate the pureed food immediately after preparation and to discard any remainders after 24 hours. Parents were also instructed on how to flush the G-tube following food boluses to prevent tube clogging due to the viscosity of the feedings.

Amounts of vitamin and mineral supplementation were determined using the Food Processor Program. When indicated, multivitamin preparations were added to the feedings. Calcium was supplemented using calcium citrate or calcium carbonate. Electrolyte supplementation was accomplished using sodium chloride or table salt.

Feeding

Children on the PBGT diet required a 14 French or larger G-tube to prevent clogging during feeding. The diet was administered by slow push via a 60-mm syringe. For children who were on continuous drip feedings, total caloric and fluid goals were calculated at baseline. At treatment initiation, children received 50% of calories via pureed boluses, with the rest of their calories given overnight via formula. Children were then advanced as tolerated to receive their full enteral needs by pureed boluses via the G-tube.

Follow-Up

During the initial 2 weeks of the diet, the team followed the families closely via telephone to help with feeding preparation and answer questions. The child's follow-up weight

gain was recorded at each return visit to the feeding clinic, which was scheduled every 2-3 months. After children had been on the PBGT diet for a minimum of 2 months, a telephone survey was conducted. Parents were asked to rate the percentage reduction in gagging and retching since their child started the pureed diet. Families were also asked to rate whether their child's oral intake had increased.

Results

Thirty-three children aged 9 to 124 months (mean, 34.2 months; median, 28 months) were started on the PBGT diet and participated in the telephone surveys. Twenty-nine (88%) of the children carried a diagnosis of neurodevelopmental delay. All patients had undergone laparoscopic Nissen fundoplication surgery in addition to G-tube placement. These procedures were performed both at CCHMC and at numerous outlying hospitals. None of the patients were started on known motility agents such as erythromycin or metoclopramide before or while receiving the PBGT diet. Children previously were taking a variety of commercial formulas; many had tried higher calorie concentrations or thickened formulas before trialing the PBGT diet.

Patients on the PBGT diet received between 2 and 6 boluses per day (mean, 4) in varying volumes. Parents reported that it took 10 to 20 minutes to prepare a day's worth of pureed food using a standard kitchen blender. No family reported clogging of the G-tube due to the diet.

Weights from 31 of the children were obtained during follow-up clinic visits over a period of 2 to 24 months (mean, 6.2 months; median, 5 months; Table 2). Two other children were not seen by the feeding team in follow-up but did participate in the telephone survey. Children were weighed on the same scale for consistency. After initiation of the pureed diet, children gained an average of 6.2 g/d (median, 5 g/d; range, -8 to 28.9 g/d). Four children lost weight during the follow-up period. Review of clinic records demonstrated that 3 of these children regained their weight. The other patient with weight loss discontinued the PBGT diet, with the family citing that the diet was inconvenient.

The parents of 17 of 33 children (52%) reported a 76% to 100% decrease in gagging and retching after their child started the PBGT diet (Figure 1). A total of 24 of 33 (73%) children were reported to have had at least a 50% decrease in symptoms after starting the PBGT diet. Four children (12%) were reported to have a $\leq 25\%$ decrease in symptoms. No parents reported that their child's gagging or retching worsened on the PBGT diet.

In terms of improvement in oral feeding, 19 of 33 (57%) children were reported to have increased their oral intake on the PBGT diet (Figure 2). The remaining 14 patients ate the same amount or continued to take nothing by mouth. No child was reported to eat less by mouth after starting the PBGT diet.

Table 2. Age and Weight Gain for Children on a Pureed by Gastrostomy Tube Diet

Patient	Age, mo	Starting Weight, kg	Final Follow-Up Weight, kg	Follow-Up Period, mo	Weight Gain per Day, g
1	35	11.12	11.6	2	8
2	18	8.43	9.05	2	6.9
3	30	10.28	11.2	2	15.3
4	32	11.6	14.2	3	28.9
5	26	11.92	11.2	3	-8 ^a
6	18	10.93	11.9	3.5	9.2
7	30	11.5	12.33	3.5	7.9
8	29	11.83	12.8	3.5	9.2
9	9	9.36	10.36	3.5	9.5
10	21	9.43	9.8	3.5	3.5
11	51	13.1	13.9	4	6.7
12	26.5	10.57	10.1	4	-3.9 ^a
13	45	12.5	12.1	4.5	-3.0 ^a
14	11	7.64	9.45	5	12.1
15	44	11.7	14.6	5	19.3
16	30	11.2	11.4	5	1.3
17	10	7.95	8.86	5.5	5.5
18	82.5	21.5	22.1	5.5	3.6
19	12	7.67	8.57	6	5.0
20	22	10.06	10.9	6	4.7
21	29	10.3	10.8	6	2.8
22	114	18.8	20.8	7.5	8.9
23	19	9.59	10.4	7.5	3.6
24	15	8.67	10.5	8	7.6
25	20	11.52	12.4	8	3.7
26	28	6.2	5.69	9	-1.9 ^b
27	46	17.3	18.3	9.5	3.5
28	24	8.7	9.82	9.5	3.9
29	36	12.32	13.8	11	4.5
30	25	10.7	14.2	12	9.7
31	20	7.41	10.9	24	3.6
32	107	33.5	NA	NA	NA
33	63	17.2	NA	NA	NA

NA, not applicable.

^aWeight loss regained at later follow-up appointments.

^bPatient discontinued diet.

Discussion

In our series, the symptoms of gagging and retching improved in children with feeding disorders who were fed an individualized PBGT diet. More than half (17/33) of the parents reported that their child's symptoms had improved by 76% to 100%. Interestingly, parents generally reported that their child's symptoms improved almost immediately upon starting the PBGT diet. The effect appeared to be sustained, as families continued to note improvement when surveyed after 2 months of therapy. No families reported that their child's symptoms had worsened on the PBGT diet.

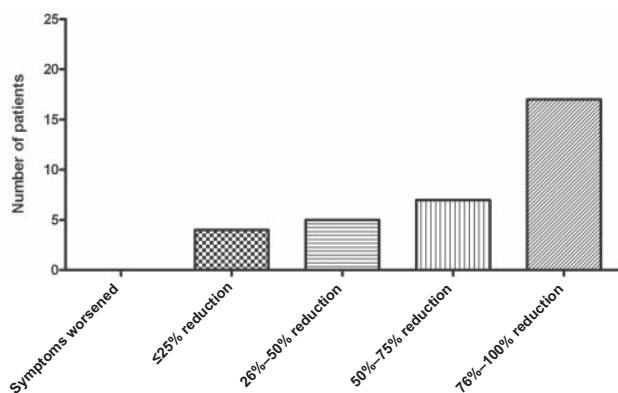


Figure 1. Reduction of gagging and retching in children (n = 33) using the pureed by gastrostomy tube diet as reported by their parents.

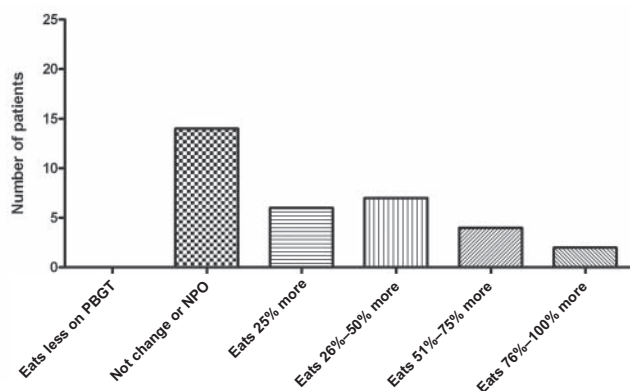


Figure 2. Change in oral intake in children (n = 33) using the pureed by gastrostomy tube diet as reported by their parents. NPO, nil per os (ie, nothing by mouth).

The increase in oral intake in a subset of patients on the PBGT diet was an interesting observation. It has been demonstrated that children with dysphagia develop oral aversion, which can improve when the underlying cause of their dysphagia is corrected.¹⁴ In our series, the decrease in gagging and retching on pureed feeds may have decreased oral aversion, making the child more receptive to eating by mouth.

Several other points came out of this series. Parent satisfaction with the PBGT diet was exceptionally high, with only 1 family opting to switch back to regular formula after the initial trial period. Parents' primary reason for continuing the PBGT diet was improved symptoms, although some families viewed pureed foods to be more "natural" than formula. Anecdotally, several parents reported that their child had decreased constipation on the PBGT diet, but we did not measure this outcome.

The cost of using the PBGT diet was both a positive and a negative factor. We estimated that a day's worth of the PBGT diet was \$6.20 compared with \$8.00 for equivalent calories using commercial formulas. However, unlike formulas, purees are often not covered by insurance companies, so many families paid for the diet themselves.

Several significant limitations to this study remain. Gagging and retching after fundoplication surgery have been reported to improve in some children over time without therapy.¹⁵ It is possible that this influenced our results. However, families typically reported a decrease in symptoms almost immediately upon starting the PBGT diet, making this factor less likely.

Because all children initiated the PBGT diet in the outpatient setting, we were forced to rely on parental recall of the child's symptoms. It is possible that parents incorrectly estimated the degree of symptom improvement. Despite this possibility, the high level of parental satisfaction and large proportion of families who reported that their child's symptoms had decreased by at least 50% indicated that some significant improvement was observed. A larger, prospective trial is needed to validate these points.

Parents' reports that their child's oral intake increased with the PBGT diet were not likely to be solely attributable to the diet itself. The children in our series were seen in the context of our multidisciplinary feeding team, and most were actively receiving additional therapy through speech, occupational, and physical therapy services. We were unable to distinguish the impact of these therapies on oral intake compared with the PBGT diet. Given that none of the children on the PBGT diet were reported to have decreased oral intake while on the diet, it appears that the diet does not adversely affect children's ability to eat.

We obtained blood work (ie, complete blood count, liver profile, renal panel, glucose) in a subset of patients trialing the PBGT diet. Because the results were within normal limits, we did not perform laboratory tests on every patient during the trial period. Although no child was reported to have an adverse outcome from the pureed diet, it is possible that subclinical electrolyte or nutrition changes were missed. It is now our standard practice to screen patients on PBGT diets at their 3-month clinic appointments, and no major abnormalities have been found to date.

We identified several barriers to using a PBGT diet. The diet must be individualized to the child's nutrition needs and preferences. This requires experienced dietitians who are able to create and modify the diet over time. In reviewing other blenderized diets, Sullivan et al¹³ noted that the nutrition content of such diets varied widely and that their caloric content was often overestimated. For this reason, we advocated the use of a licensed nutrition processing program to help maintain

consistency. However, despite this precaution, we had the same difficulty because several of our patients had poor weight gain after starting the PBGT diet. Our dietitians were able to modify the diets to increase calories, but this issue requires close follow-up of the patients' weights.

To provide age-appropriate foods, we required children to be older than 8 months before trialing the PBGT diet, which limits the use of this diet in younger children. The pureed food requires refrigeration, which may affect families' ability to travel. A PBGT diet also requires a time investment from the family to blend the foods each day as well as to give boluses via gravity. In theory, the increased viscosity of the feed can lead to clogging of the G-tube, although we did not see this in our series.

The mechanism of action of the PBGT diet in decreasing gagging and retching is not entirely clear. A potential cause is that the higher viscosity of the feedings allows for slower emptying of the stomach, leading to a decrease in dumping syndrome. It is also possible that pureed foods stimulate a different hormonal response that favorably affects gastrointestinal motility compared with the response from formula. Future techniques to study the effects of a PBGT diet could include glucose tolerance testing after feedings. Other options include serial gastric emptying scans or manometric studies before and after initiation of the diet, although it is possible for patients to have clinical symptoms of dumping syndrome with normal test results.⁷

In our experience, a PBGT diet can decrease gagging and retching as well as increase oral intake in children with feeding disorders after fundoplication surgery. In addition, the PBGT diet can provide a nutritious alternative to formula for children who require long-term EN therapy. Further investigations are needed to better characterize the effectiveness of a PBGT diet, its mechanism of action, and other potential indications for such a diet.

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