Percutaneous gastrojejunostomy versus Nissen fundoplication for enteral feeding of the neurologically impaired child with gastroesophageal reflux

Craig T. Albanese, MD, Richard B. Towbin, MD, Ibrahim Ulman, MD, Jody Lewis, RN, and Samuel D. Smith, MD

From the Departments of Pediatric Surgery and Radiology, Children's Hospital of Pittsburgh and University of Pittsburgh, Pittsburgh, Pennsylvania

To determine the optimal method of providing enteral feeding to neurologically impaired children with gastroesophageal reflux, Nissen fundoplication with simultaneous gastrostomy tube placement (NGT) was compared with anterograde percutaneous gastrojejunostomy (APGJ), a nonsurgical procedure performed under fluoroscopic guidance. The records of 112 neurologically impaired children with gastroesophageal reflux were retrospectively reviewed; 68 had undergone NGT and 44 APGJ. Follow-up data were available for 45 NGT patients (mean age, 6.4 years) and 34 APGJ patients (mean age, 7.9 years). Mean follow-up was 1.8 years in the NGT group and 2.5 years in the APGJ group. Complications resulting from either procedure were classified either as major, which included treatment failures or morbidity resulting in prolonged hospitalization, or as minor, those requiring outpatient treatment only or not directly caused by the procedure. The NGT group had a significantly higher incidence of major complications in comparison with the APGJ group (33.3% vs 11.8%, $p < 0.05$). Ten patients (22.2%) in the NGT group required reoperation for complications; six required a second NGT for wrap hernia, failure, and continued gastroesophageal reflux. Two patients (5.9%) in the APGJ group required surgery for complications; one of these eventually required an NGT, and the other had an intussusception that necessitated a small-bowel resection. Minor complications were more common in the APGJ group than in the NGT group (44.1% vs 6.6%); the majority of complications were related to the jejunostomy tube. Premature replacement or reinsertion of the jejunostomy tube was necessary in 14 APGJ patients (32%). The mortality rate was 8.8% in the NGT group and 5.9% in the APGJ group (p = not significant). No death occurred within 30 days of either procedure. We conclude that APGJ is a safe alternative method for feeding the neurologically impaired child with gastroesophageal reflux. (J Pediatr 1993;123:371-5)

The standard procedure for treatment and feeding of neurologically impaired children with gastroesophageal reflux is a Nissen fundoplication with simultaneous gastrostomy tube placement[1-4] to prevent GER with its attendant morbidity. It also provides access for either intermittent or continuous intragastric feeding; many of these patients cannot be fed by mouth because of swallowing difficulties. Al

APGJ	Anterograde percutaneous gastrojejunostomy
GER	Gastroesophageal reflux
NGT	Nissen fundoplication with gastrostomy tube

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Reprint requests: Craig T. Albanese, MD, Department of Pediatric Surgery, Children's Hospital of Pittsburgh, 3705 Fifth Ave. at DeSoto St., Pittsburgh, PA 15213-2583.

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though the majority of patients are effectively treated by this approach, many have significant postoperative complications requiring reoperation, the most common of which is recurrent GER.[1, 2, 4-11]

The interventional radiologists at our institution have been providing neurologically impaired children with a nonsurgical approach to enteral feeding—anterograde percutaneous gastrojejunostomy. Under fluoroscopic guidance and local anesthesia, a percutaneous gastrostomy tube is placed. A feeding tube is then passed into the jejunum through the gastrostomy catheter, allowing for continuous feeding. The safety and efficacy of this method as a means of delivering enteral feedings to children with a variety of diseases are well established.[12-19]

The purpose of this study was to determine the optimal method for enteral intake for the neurologically impaired child with GER.

METHODS

The records of 112 neurologically impaired children were retrospectively reviewed from March 1986 to September 1991. A total of 68 children underwent NGT, and 44 underwent APGJ. Follow-up data were available for 45 NGT patients and 34 APGJ patients, and were the basis of this study.

All 79 children had documented central nervous system disease before evaluation for GER. The most common diagnoses were encephalopathy (both static and progressive forms), severe mental retardation, and seizure disorder. All patients were nonverbal, nonambulatory, and unable to tolerate feeding by mouth or to provide self-care. All patients in both groups had symptomatic GER confirmed by positive findings on one or more of the following objective studies: upper gastrointestinal tract series, esophageal pH probe, esophageal endoscopy, and technetium scan.

The indications for treatment in both groups, after failed medical therapy, were principally nutritional and respiratory. An APGJ or NGT was performed solely on the basis of the procedure for which the patient was referred. No patient was denied either procedure because of severity of GER, comorbid conditions, degree of neurologic impairment, type and duration of preoperative medical management, or life expectancy.

A Nissen fundoplication with posterior approximation of the crura, 360-degree fundic wrap, and Stamm gastrostomy via a standard transabdominal approach was performed in all NGT patients. All patients were operated on by one of six pediatric surgeons at Children's Hospital of Pittsburgh. Preoperative medical management (e.g., antacids, H_2 blockers, or metoclopromide) was discontinued after surgery in all patients. Follow-up of all patients was done by the pediatric surgeon, a nutrition support nurse, and the referring pediatrician.

Patients in the APGJ group were derived from three institutions (Children's Hospital of Pittsburgh, Children's Hospital of Cincinnati, Children's Hospital of Michigan), but all procedures were performed or supervised by the same radiologist (R.B.T.). A detailed description of the technique is published elsewhere.[12] Briefly, the procedure was performed in the radiology department with the patient under intravenously administered sedation and given locally administered anesthesia. The left hepatic lobe was identified sonographically. Contrast medium was administered orally or a contrast enema was performed to identify the transverse colon. A nasogastric tube was inserted to insufflate the stomach. An orogastric tube was placed and exchanged for a Dotter retrieval basket or snare (Cook Inc., Bloomington, Ind.). The abdominal wall and the stomach were punctured with an 18-gauge needle, and a wire was inserted into the stomach, captured with the basket or snare, and withdrawn from the mouth. A size 14F Sacks-Vine gastrostomy tube (Ross Laboratories, Columbus, Ohio) was placed over the wire in an anterograde fashion and pulled through the stomach and abdominal wall. A size 8 modified Frederick Miller tube (Cook Incorporated, Bloomington, Ind.) was coaxially inserted into the proximal jejunum. The tubes were secured to one another by coating them with tincture of benzoin and wrapping them with an adhesive dressing. Feeding by continuous pump infusion was begun the next morning. Patients were discharged when feedings were tolerated, usually after 48 hours.

The gastrostomy tube was left in place for as long as it was needed or until it began to deteriorate. (The current generation of gastrostomy tubes usually lasts between 1 and 2 years.) The jejunostomy tube was changed routinely every 3 to 4 months to avoid hardening and potential enteric injury. Replacement of the jejunostomy tube required fluoroscopic guidance. The only absolute contraindications to APGJ were coagulopathy and inaccessible anatomy. Relative contraindications were esophageal and gastric outlet obstruction. All patients continued their preoperative antireflux medical regimen after placement of the APGJ tube.

All APGJ patients were followed by a nutritional support team consisting of an intervention radiologist, gastroenterologist, dietitian, and clinical nurse specialist in conjunction with the referring pediatrician.

The NGT and APGJ groups were compared with respect to age, sex, height, weight, weight for height, cause of neurologic impairment, and the morbidity and mortality rates associated with each procedure. Complications were tabulated either major or minor. Major complications were treatment failures or those which resulted in prolonged hospitalization

Table I. Patient characteristics

	NGT	APGJ
Age (yr)*	6.4 (2 mo to 19 yr)	7.9 (2 mo to 17 yr)
Sex (M/F)	20.25	13.21
Weight (kg)*	26.3 (4-70)	30.1 (4-54)
Height (cm)*	88.5 (48-152)	93.5 (46-161)
Weight/height (percentile)	5th	5th

*Values are means, with ranges in parentheses.

requiring either medical or operative treatment. Minor complications were those which required outpatient treatment or were found not to be due to the procedure itself. The average cost and duration of hospitalization after an uncomplicated procedure were tabulated for both. Follow-up was obtained by the hospital records, clinic and office charts, and telephone contact. Results were analyzed by chi-square analysis and the Student *t* test where appropriate. A p value <0.05 was considered significant.

RESULTS

Follow-up averaged 1.9 years (range, 6 months to 5 years) in the NGT group and 2.5 years (range, 6 months to 5.6 years) in the APGJ group. Patients were matched with respect to age, sex, height, weight, and weight for height (Table I). There were no differences in the cause of neurologic impairment between groups. There was a 98% technical success rate for the APGJ procedure; in one patient the stomach was inaccessible percutaneously (too superiorly situated for safe puncture).

The NGT group had a significantly higher incidence of major complications in comparison with the APGJ group (33.3% vs 11.8%; $p <0.05$) (Table II). A total of 10 patients (22.2%) in the NGT group required reoperation for complications (Table II). Six underwent a second NGT (one of these required a third, another a fourth). Two patients had a small bowel obstruction that required enterolysis. Two patients had a gastrostomy tube leak with peritonitis that required operative repair. In two of the three patients, continued GER has been successfully managed medically. One *Staphylococcus aureus* wound infection occurred that necessitated intravenous antibiotic therapy and open packing of the wound.

A total of 2 patients (5.9%) in the APGJ group required surgery for complications (Table II). This complication rate was significantly lower than in the NGT group ($p <0.05$). One patient continued to have reflux of feedings and required an NGT; this patient had a flaccid encephalopathy. One patient had an intussusception, with the jejunostomy tube as the lead point; a small bowel resection was performed.

Table II. Major complications after NGT and APGJ

NGT		APGJ	
Complication	No.	Complication	No.
Recurrent reflux requiring surgery	6	Intussusception*	1
Recurrent reflux managed medically	2	Continued GER*	1
Small bowel obstruction*	2	Pneumonia	2
Peritonitis*	2		
Pneumonia	2		
Pancreatitis	1		
Total	15 (33.3%)	Total	4 (11.8%)

*Required surgical correction.

Minor complications were significantly higher in the APGJ patients than in the NGT patients (44.1% vs 6.7%, $p <0.05$). The majority were related to jejunostomy tube placement and required either reinsertion or placement of a new tube (without complication). None of the complications was referable to the gastrostomy tube. The single wound infection responded to intravenous antibiotic therapy and local wound care. There were no cases of postprocedure pneumoperitoneum, peritonitis, or pancreatitis in the APGJ group. No patient required general anesthesia, nor were there any complications of local anesthesia. Two patients in the NGT group had retching and dysphagia postoperatively. This complication was not due to recurrent GER; findings of the upper gastrointestinal tract series and of the esophageal pH probe analysis were normal in both patients.

Mortality rate in the NGT group was 8.8% (4 patients) and in the APGJ group 5.9% (2 patients) (p = not significant). In the NGT group, two deaths were due to sudden respiratory arrest and two others from aspiration. One death in the APGJ group was due to seizures, and the other was of an unknown cause. No death occurred within 30 days of either procedure.

The surgeon's fee for an NGT was $3400; the average hospital stay was 6 to 8 days. The radiologist's fee for the APGJ was $3309; the average hospital stay was 1 or 2 days. Each gastrojejunostomy tube change cost $473.

DISCUSSION

We studied two different methods of feeding neurologically devastated children with symptomatic GER. Although retrospectively derived, our results suggest that APGJ can provide enteral feeding with significantly lower major morbidity than NGT. A significant advantage of APGJ is that if it fails, surgical therapy is still an option (one patient in this series). Conversely, a failed NGT may be

treated by the placement of a jejunostomy tube through the gastrostomy tube, creating the APGJ and obviating the need for major surgery.

Data from Wilkinson et al.[20] and from Jolley et al.[21] are the basis for the standard of care of neurologically impaired children with documented GER who cannot tolerate feeding by mouth—an antireflux procedure with gastrostomy tube insertion. Some of the data indicate that placement of a gastrostomy tube alone, without an antireflux procedure, can exacerbate preexisting symptomatic GER.[22, 23] Antireflux surgery in these patients, however, is associated with a 16% to 45% incidence of significant surgical complications, such as recurrent reflux, small bowel obstruction, and postoperative pneumonia.[1, 2, 4-11] Approximately 10% to 25% of those with recurrent reflux will require reoperation for wrap hernia and wrap failure.[4, 6, 8-10] Our data are similar. In contrast, APGJ was associated with fewer major complications, and fewer patients required surgery for recurrent reflux.

The use of fluoroscopically inserted percutaneous feeding tubes was first introduced by Sacks and Glotzer[24] in 1979. Shortly thereafter, Gauderer et al.[25] introduced an alternative technique for the nonsurgical, percutaneous placement of a gastrostomy tube by using endoscopic guidance. In 1983, Sacks et al.[26] modified the endoscopic technique so that gastrostomy tube placement could be fluoroscopically guided. During the ensuing 8 years, numerous reports have documented both the advantages of the percutaneous fluoroscopic technique in adults and children and a technical success rate of 98% to 100%. Major complications are reported to occur in up to 6% of cases and minor ones in 14%; the mortality rate is approximately 1%.[12-19, 27]

There are theoretical and practical drawbacks to the APGJ. Patients are at continued risk for vomiting and aspiration of gastric fluid, for two reasons: (1) APGJ does not treat GER, necessitating that patients continue medical management, and (2) the gastrostomy tube serves solely as a conduit for the jejunostomy tube and cannot simultaneously decompress the stomach. Aspiration pneumonia was rare in this group, possibly because there was no intragastric feeding with its associated gastric distention. Continued medical management in this setting may be adequate to prevent or decrease clinically apparent aspiration. Neither procedure, however, prevents aspiration of oropharyngeal secretions related to the swallowing difficulties frequently present in these patients. Furthermore, jejunostomy tube loss accounts for significant minor morbidity. This results from a tenuous system of affixing the jejunostomy to the gastrostomy tube.

Our study demonstrates that APGJ, in comparison with NGT, is associated with a substantially lower rate of major complications and has a technical success rate that approaches 100%. We conclude that APGJ is a safe alternative method of feeding the neurologically impaired child with GER.

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