Gastroesophageal Reflux in Childhood

The Dilemma of Surgical Success

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Successful surgical correction of gastroesophageal reflux has prompted frequent and early referral of children for antireflux surgery. This report describes the results and defines the complications in a series of children treated surgically for gastroesophageal reflux. Methods are suggested to reduce the occurrence of these postoperative complications. In five years (1977–1981), 117 children, 3 weeks to 16 years old, were operated on for gastroesophageal reflux at The Oklahoma Childrens Memorial Hospital. Nissen fundoplication was performed on 111 of them. Patients have been followed for 3 months to five years. At most recent examination, clinical success (remission of symptoms) has been accomplished in 81 of 92 patients (90%). In 86 patients evaluated radiographically, gastroesophageal reflux was absent in 83 and persistent in 3. There were no operative deaths. Twenty-three major complications occurred in 21 patients, 13 of whom required reoperation. These major complications were paraesophageal hiatal hernia (ten patients), small bowel obstruction (eight patients), and wrap malalignment (5 patients). Observations of and reoperation on these children suggests the following necessary steps for avoidance of complications in children: (1) Nissen fundoplication in childhood should be accompanied by an accurate multi-suture crural repair and by suture fixation of the fundal wrap to the crura and to the abdominal surface of the diaphragm; (2) appropriate alignment of the fundal wrap and of the crural repair is best accomplished with a large indwelling esophageal bougie of sufficient size to efface and blanche the esophageal musculature; and (3) appropriate care in avoiding small bowel obstruction mandates meticulous avoidance of trauma to the liver capsule and small bowel serosa.

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IN CHILDHOOD, a variety of clinical problems, ranging from feeding difficulty to respiratory arrest, is being attributed to gastroesophageal reflux.[1,2] Concomitant with this increased recognition of gastroesophageal reflux is an escalating referral of patients with that process to the surgeon for treatment.[3] Referral of patients for surgery is occasioned by the difficulties and sometimes ineffective results of medical therapy, by the serious nature of some complications of reflux, and by the general success of surgical intervention.[4–7] In our experience, success of surgical treatment has been nearly uniform, but complications from surgery, particularly complications requiring further surgical intervention, have been common. This report describes the results and defines the complications in a series of children treated surgically for gastroesophageal reflux. Methods are suggested to reduce the occurrence of these postoperative complications.

Methods

In five years (1977–1981), 117 children, referred to the Surgical Service at Oklahoma Children's Memorial Hospital for consideration of surgical correction of gastroesophageal reflux, underwent an operative procedure for elimination of reflux (Table 1). Typically, these children had the diagnosis of gastroesophageal reflux previously established, and were referred by their physician with the request for, and expectation of, an operative procedure for their reflux. In most instances, indicated medical treatment had been carried out prior to referral. The 117 children were 3 months to 16 years of age; 61 children were less than 1 year of age. Sixty-seven were boys and 50 girls. Upper gastrointestinal series (upper GI) was the hallmark for diagnosis. One hundred fifteen patients had upper gastrointestinal series positive for gastroesophageal reflux; all studies were performed in standard fashion by the Radiology staff at Oklahoma Children's Memorial Hospital. A variety of other diagnostic studies were obtained in difficult cases or at the discretion of the referring physician.

Presented at the Ninety-Fourth Annual Meeting of the Southern Surgical Association, December 6–8, 1982, Palm Beach, Florida.

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Submitted for publication: December 22, 1982.

0003-4932/83/0500/0560 $01.10

TABLE 1. *Surgery for Gastroesophageal Reflux in Childhood*

Year	No. of Patients
1977	2
1978	7
1979	22
1980	38
1981	48
Total	117

Although there was considerable overlap, each patient could be assigned a primary indication for surgery (Table 2). One hundred eleven patients had Nissen fundoplication. In six patients, mostly small infants, Nissen fundoplication could not be accomplished. In five children, the operation performed was a partial wrap fundoplication and, in one, a Hill operation.

Patient follow-up was scheduled for three months and one year following operative procedure, with yearly follow-up subsequent to that time. At each examination, clinical assessment was made and an upper GI series obtained. Follow-up was current through September 1982.

Results

Deaths

No child died of events or causes related to the operation. Thirteen died during the study period, 2 to 25 months following their surgical procedure (Table 3).

Results of Treatment

Clinical results of treatment are tabulated in Table 4. As of their most recent examinations, 81 of 92 patients (90%) had satisfactory clinical results with resolution of symptoms (Table 5). Repeat evaluation for gastroesophageal reflux was negative in ten of the 11 treatment failure patients. A single infant with continued apnea and gastroesophageal reflux on study was reoperated on with reconstruction of his Nissen fundoplication, correction of his symptoms, and remission of his radiographic gastroesophageal reflux. Radiographic correction of gastroesophageal reflux could not be evaluated in 31 patients (13 deaths and 18 incompletely studied patients). In the 86 patients evaluated, gastroesophageal reflux was absent in 83 and persistent in three.

TABLE 2. *Primary Indication for Surgery*

Brain damage	40
Vomiting/FTT	22
Apnea	19
TEF with GER	13
Recurrent pneumonia	12
Esophagitis	8
Asthma	3
Total	117

TABLE 3. *Cause of Deaths*

Sickle cell crisis	1
Pulmonary failure	2
Cardiac surgery	1
Unknown	1
Brain damage	8
Total	13

Complications

Seven patients had minor complications subsequent to their surgery. Twenty-three major complications occurred in 21 patients (Table 6). One patient with a paraesophageal hernia had upper gastrointestinal bleeding. That child, as well as four others with enlarging herniation, had transabdominal repair of their hiatal hernias. There are no secondary recurrences to date. Each of the eight patients with small bowel obstruction was symptomatic. Seven required lysis of intraabdominal adhesions, two of these requiring small bowel resection—one for intussusception and one for short segment volvulus. Wrap malalignment, manifest by recurrent gastroesophageal reflux or by an obstructed esophagus, occurred in five patients. Three children, two with esophageal obstruction and one with recurrent gastroesophageal reflux, had revision of their fundoplication with remission of symptoms and elimination of gastroesophageal reflux.

Discussion

Indications and Treatment

Pediatricians and other physicians caring for infants and children increasingly are diagnosing gastroesophageal reflux as a causative factor in a host of diseases and symptoms in their patients. Referrals for life threatening events and for true medical failures continue. However, for many patients, medical treatment consisting of upright positioning, preferably in the prone position, and

TABLE 4. *Results of Operative Treatment for Gastroesophageal Reflux*

Length of Follow-up	Deaths Total	Lost to Follow-up Total	Evaluated Patients	Treatment	
				Success	Failure
3 Months	4	—	113	113	0
1 Year	9	4	96	91	5
2 Years	12	8	60	57	3
3 Years	13	11	31	29	2
4 Years	13	12	10	9	1

TABLE 5. *Summary of Results*

Deaths	13
Inadequate follow-up	12
Latest examination	
Success	81
Failure	11

thickening of feeds is cumbersome and open-ended in duration.[4,8] Parental dissatisfaction with the physical detachment from infants that is inherent in positional therapy has resulted in refusal of that treatment. Physicians caring for children seem well acquainted with the natural history studies of Carré, which have shown that recovery from gastroesophageal reflux, whether spontaneous or attendent to positional therapy, is much diminished in the patient with gastroesophageal reflux persisting after the first birthday.[5] We believe that it is as a result of these considerations that increasing numbers of children are referred to surgical therapy for their reflux. In our experience, these referrals come not only from physician preference but also from parental request in situations where there is knowledge of surgical therapy for gastroesophageal reflux. Increasingly, surgeons are being sent children predetermined to be suitable for antireflux surgery.

Surgery in our patients has been effective in ameliorating symptoms of gastroesophageal reflux—whatever the presenting symptom (Table 7). However, success has been most consistent in those situations, such as apnea, where careful workup before operation can establish the relationship of gastroesophageal reflux to the particular symptom. In 19 patients, there was one early failure to resolve apnea. This was corrected with reoperation; the remaining 18 infants all had immediate postoperative elimination of apnea. Similarly, in those patients with vomiting and/or failure to thrive as their predominant symptom, 60 of 62 had correction of their clinical problem. It should be noted that 40 of the 62 patients had some degree of brain damage, and that many had their postoperative feedings via a gastrostomy tube with a "protective" Nissen fundoplication. Success was less frequent in patients with recurrent pneumonia and asthma. It is likely that these diseases are multifactorial and are accompanied by existing airway or pulmonary parenchymal disease. Careful and considered attention to preoperative workup and history remain mandatory in selecting accurately those patients to be benefited by fundoplication.

TABLE 6. *Complications of Surgical Treatment of Gastroesophageal Reflux*

Age	No. of Patients	Complications			
		Major			
		Hiatal Hernia*	SBO†	Wrap‡	Minor
0–6 Months	46	5 (3)	5 (4)	2 (1)	3
7–12 Months	15	1	—	—	1
1–2 Years	22	1	2 (2)	—	—
3–5 Years	15	1	—	—	1
6–16 Years	19	2 (2)	1 (1)	3 (2)	2
Total	117	10 (5)	8 (7)	5 (3)	7

( ) = Reoperations.
* Post operative paraesophageal hiatal hernia.
† Small bowel obstruction.
‡ Malalignment fundal wrap and (or) crural repair.

TABLE 7. *Results of Surgical Treatment by Indication*

Indication	No. of Patients/ No. of Failures	Type Failure	Comment/Failure
Asthma	3/3	Persistent asthma	All negative for GER
Pneumonia	12/5	Persistent pneumonia	All negative for GER
Apnea	19/1	Persistent apnea	Positive for GER Reop—corrected
Vomiting/FTT Feeding	62/2	Persistent FTT	Each negative for GER Complex disease

Nissen fundoplication was chosen as the standard operation in our infants and children. DeMeester has shown it to be an effective antireflux procedure.[9] Nissen and Bettex, in a 25-year experience, have demonstrated that Nissen fundoplication retains its effectiveness during growth and development, and need not interfere with appropriate childhood maturation.[10,11] We consider these essential issues in choosing an operative procedure to perform on infants and children.[12]

Complications

Nissen fundoplication was performed according to a technique previously described.[13] Both vagal trunks are positioned within the wrap, and the hepatic vagal branches are not transected. Intraoperative complications were rare. One patient had a small transverse colotomy during abdominal incision. This was repaired primarily without sequelae. Complications differed from those described for adults.[14,15] There were no splenic injuries, and no splenectomy or splenic resection was performed. Children younger than one year of age had gastrostomies routinely as part of their operative procedure; these were used occasionally for "burping." The gas bloat syndrome was not encountered in any patient older than twelve months at the time of surgery. Three infants treated with Nissen fundoplication for pernicious vomiting were weaned from gastrostomy feedings only with the help of a psychologic reinforcement program. No esophagitis was present before or after operation in

these three children; it is likely that their reticence to eat was behavioral.

Minor complications. Seven minor complications occurred in the postoperative period. Two patients had pneumonia which required treatment with antimicrobials. Two infants who were debilitated at the time of surgery required total parenteral nutrition before they could be weaned from ventilatory support. Other minor complications included wound infection, requirement of tracheostomy for pulmonary toilet, and a hysterical conversion reaction—each in one patient.

Major complications. Repetitive and consistent follow-up, comprising clinical and radiographic evaluation, has identified 3 complications of major consequence: postoperative paraesophageal hiatal hernia, small bowel obstruction, and malalignment of the fundal wrap (Table 6). These complications cluster in the patients youngest and oldest at operation. All complications to date have been identified in the first 2 years following surgery, although 41 patients have been evaluated 3 or more years following their operative procedure (Table 8).

Paraesophageal hiatal hernia. Paraesophageal hiatal hernia is a recognized complication of fundoplication for gastroesophageal reflux.[16] Bettex and Kuffer reported this complication in 12 of 191 patients undergoing Nissen fundoplication.[17] In their series, the herniation tended to enlarge, and they felt reoperation was indicated. In our series, ten children have developed paraesophageal hiatal hernia. The radiographic appearance has been consistent with a portion of the fundus herniating beside the esophagus into the mediastinum (Fig. 1). There has been no instance of the fundal wrap slipping around the body of the stomach as described by Polk.[18] One 8-year-old boy was symptomatic from a large paraesophageal hiatal hernia and gastrointestinal bleeding identified at endoscopy (Fig. 2). With repair of the hiatal hernia, gastrointestinal bleeding ceased and has not recurred during 2-year follow-up. The remaining nine patients were asymptomatic and had their hernia identified only at upper gastrointestinal series that was done as part of routine follow-up. Four of these nine patients have been reoperated on for repair of their paraesophageal hernias which, on repetitive follow-up, increased in size. Of the ten patients with paraesophageal hiatal hernia, one older child had no crural repair, the remaining nine including the five reoperated patients had single suture closure of their hiatus. At reoperation, each had herniation into the esophageal hiatus of a portion of the stomach fundus mobilized for esophageal wrap. At secondary repair, the herniated fundus was returned to the abdominal cavity. A multi-suture closure of crura was performed using large sutures (0 or 2-0 braided Nylon); the fundus of the stomach was sutured to the crural repair and to the abdominal surface of the diaphragm. In follow-up of 4 months to two years, there has been no recurrence of paraesophageal hernia. These intraoperative observations suggest that hiatal obliteration with crural approximation is a necessary component of fundoplication in infants and children. In the past year, we have embarked on an operative technique comprising minimal disection of peritoneum from the crura, large multisuture approximation of the crura, and fixation of the fundal wrap to the crura and to the undersurface of the diaphragm. To date, one hernia has occurred in this group. Follow-up for these patients with enhanced repair indicates continued success of the fundoplication in eliminating gastroesophageal reflux. If our new techniques of initial and secondary repair eliminate

TABLE 8. *Interval Surgery to Complication*

Interval to Dx	Wrap	Hernia	SBO
0–3 Months	5	—	4
4–12 Months	—	5	2
1–2 Years	—	5	2
3–5 Years	—	—	—

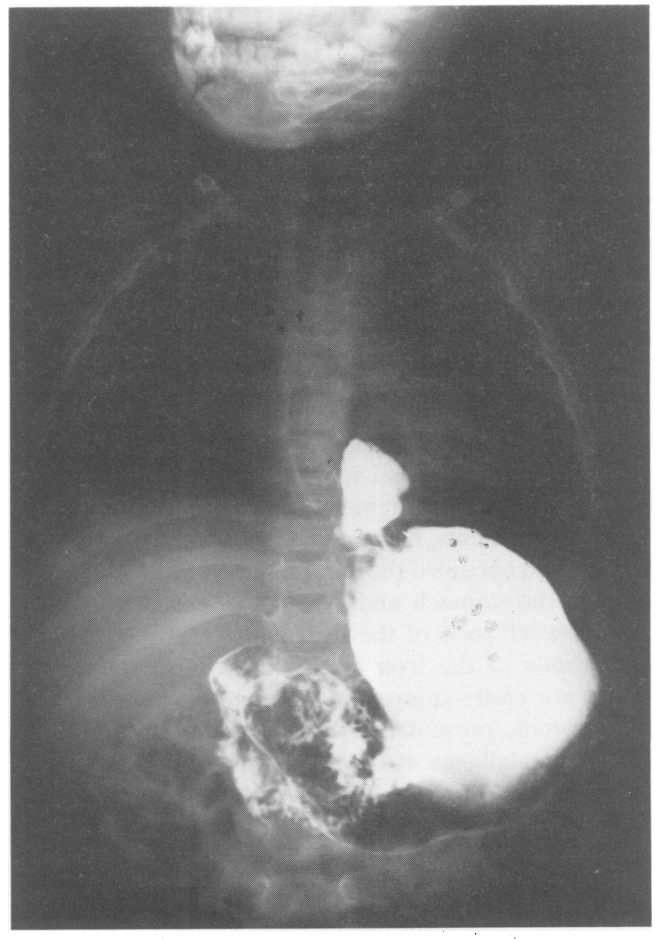

FIG. 1. Typical radiographic appearance of a postoperative paraesophageal hernia.

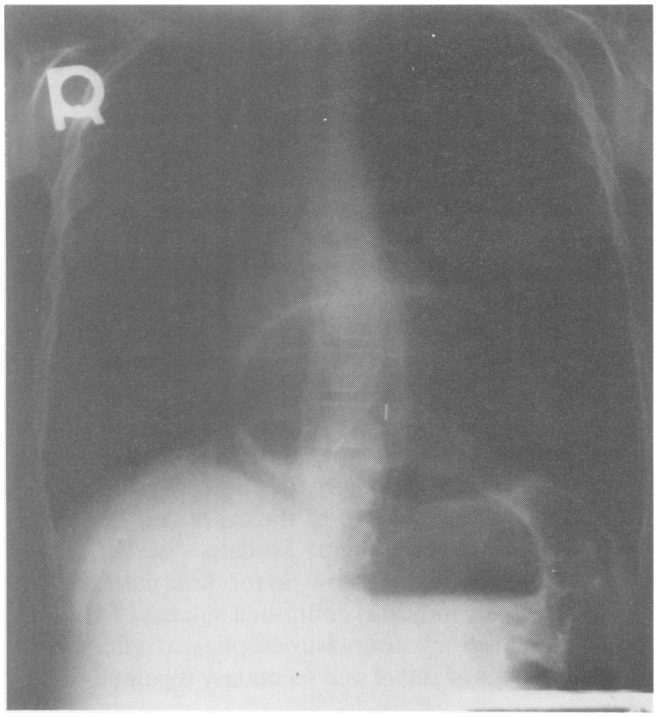

FIG. 2. Large paraesophageal hernia in patient with upper gastrointestinal bleeding.

further paraesophageal herniation, we plan to electively repair remaining paraesophageal hernias.

Small bowel obstruction. Eight patients have developed small bowel obstruction. This is an excess of the 2% incidence of small bowel obstruction following laparotomy of other types of surgery in infants and children.[19] One child with partial obstruction was treated successfully with a nasogastric tube, while the remaining seven patients, two with intussusception and five with adhesive obstruction, required operation. As is typical following upper abdominal exploration in infants and children, intraperitoneal adhesions were extensive with considerable involvement of the liver capsule. In our obstructed patients, numerous loops of small bowel had entered and occupied the left upper quadrant with adhesions to the stomach and the liver. We no longer mobilize the left lobe of the liver and specifically protect the capsule of the liver and the serosa of the bowel, which are easily injured in infants and children. No other specific preventive measures are apparent.

Wrap malalignment. Five patients have been identified as having problems of wrap malalignment with dysfunction of the hiatus-fundal wrap complex. (In each, operative technique deviated from our standard method of esophageal stenting.) Four of these patients had esophageal obstruction after operation. One infant persisted with apnea and evidence of gastroesophageal reflux. He was reoperated on, and the wrap was made more snug, eliminating his symptoms and radiologic reflux. Two of the four patients with esophageal obstruction responded to dilations. Two did not respond and were reoperated on. In both cases, the crural repair was too tight about the esophagus. The repair was revised with remission of symptoms and maintenance of gastroesophageal competence. In all five patients, wrap dysfunction was evident in the first 3 months following surgery. Only one instance of wrap malalignment has occurred in the past 18 months. This complication has been obviated by rigid adherence to a specific technique of esophageal stenting. We pass an oral-gastric bougie of sufficient size to efface and blanch the wall of the esophagus. This stenting is maintained as the wrap is constructed and as the crura are approximated. When this technique has been rigorously adhered to, no instances of either obstruction or immediate recurrence of gastroesophageal reflux have occurred.

Conclusion

Johnson and his colleagues have suggested a graded surgical approach to gastroesophageal reflux in childhood, reserving Nissen fundoplication for the most flagrant symptomatology.[8] This thesis has not been systematically tested. We continue to believe that the proven efficacy and compatibility of the operation with all ages of children[20] identifies it as the operation of choice for childhood gastroesophageal reflux.

Scant attention has been paid to complications of Nissen fundoplication in papers previously discussing this surgery in childhood. The complications detailed in this series indicate that Nissen fundoplication is major surgery when performed in infants and children. Such surgery has life-long implications relative not only to the elimination of gastroesophageal reflux but also the occurence of complications attendant to intraperitoneal surgery. We would emphasize that fundoplication be performed only in children in whom it truly is indicated.[8] In avoiding complications with fundoplication, intraoperative techniques of value include adequate intraluminal stenting of the esophagus, accurate large suture closure of the esophageal hiatus, and fixation of the fundal wrap to the crural repair. As in all childrens' surgery, intraperitoneal management must minimize trauma to the liver and small bowel. Hopefully attention to preoperative diagnosis and assessment and a meticulous performance of the operative procedure will continue the good reputation of surgery in the treatment of gastroesophageal reflux in infants and children.

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Discussion

DR. HIRAM C. POLK, JR. (Louisville, Kentucky): Before getting on to the substance of this paper I would like to remind you that most of the points of technical finesse stressed for the child really do apply to the adult as well. For example, the problems of adhesions to the under surface of the mobilized left lobe of the liver is a particular problem; we do a fair number of reoperations for previous failures, and that is the first major technical problem in reoperation of these cases.

My own interest in this began some time ago, when Dr. Ravitch was kind enough to publish in the Pediatric Surgery Section of *Surgery,* when he and I were both younger, a paper that I had done based on some anecdotal experiences of Dr. Thomas Burford (Surgery 54:521–525, 1963). He had operated on three children with this illness over a long period of time with a standard crural repair kind of operation. We correctly identified the fact that these children get into failure to thrive and gastroesophageal reflux business, and almost never show up with symptoms that are typical of hiatal hernia and reflux esophagitis in the adult.

First of all, this has been a long-term follow-up. The 4-year follow-up shown here in a high proportion of patients speaks well for the outcome. In other words, the authors have honestly looked for their failures. Many of the good results described in this field are based on sending in your cards and letters, and never carefully looking for one's own failures.

The complication rate that is stressed here is very similar to ours, presented a few years ago before this society, in describing the misadventures with fundoplication in the adult. (Ann Surg 173:782, 1971). There are errors in application and technical and conceptual errors that need to be avoided if possible.

Certainly, the point of 13 out of 117 patients dying with 23 major complications is the sort of thing that gives substance to the bottom line—be careful before one undertakes this kind of operation in every child who vomits or regurgitates.

The third point that I would like to clear up is what other people call the so-called slipped-Nissen—it is the same phenomenon. Indeed, the recurrent hernia occurs usually through the plicated segment and presents identically as shown here.

I think the real question in this illness is one that was mentioned in the abstract, and was not presented, and that is: Who do you operate on, when, and how often? I think that for a time, certainly from the mid-1960s when this was first described until the mid-1970s when it was discovered by the pediatricians, the operative procedure was underdone, underutilized, and a number of children suffered because of it. Dr. Tunell has rightly put the other shoe on the foot, and said, "Now that everyone is doing it, we must carefully look at the long-range results of this operation." I think how many patients are referred, and how many patients are refractory to medical management, of course, is absolutely essential for proper interpretation of these reports.

This will be the first of the long-term studies and will set high standards for others; all we need is a further follow-up for a longer period of time.

DR. J. ALEX HALLER, JR. (Baltimore, Maryland): One of the dilemmas that Dr. Tunell did not mention, it seems, is one that relates to the very young infant. There is increasing concern on the part of many pediatricians and pediatric surgeons that reflux is responsible for the sudden infant death syndrome, which, as you will recall, occurs usually in the first year of life.

One of the real problems that we have, and the question that I would like to direct to Dr. Tunell, is how to evaluate the child under a year of age with reflux, who may be having apneic spells and might possibly even have documented aspiration. So many of these babies reflux and, as a matter of fact, if you look at the studies of the maturation of the lower esophageal sphincter in infants up through 6 to 8 months of age, pratically all normal babies reflux. A big dilemma is how to select these patients and feel confident that you are not overlooking those who may, in their next episode, die as a result of aspiration.

So I would like to ask how Dr. Tunell is managing those patients in the younger age group and what objective guidelines he is using. Is it necessary in this group of patients, and when?

DR. WILLIAM P. TUNELL (Closing discussion): A comment related to Dr. Polk's discussion: In nine of ten patients, the herniated portion of the stomach was that stomach adjacent to, but not including, that portion wrapped around the esophagus. That is, it was adjacent, mobilized fundus which had herniated through the esophageal hiatus.

Anything from vomiting to sudden infant death may be caused by gastroesophageal reflux.

The point concerning apnea made by Dr. Haller is a very real query and a very real worry in children with esophageal reflux. Children with apnea are almost always infants and, generally speaking, under 3 months of age. They were our most successful group of patients treated.

The key, was the sleep study, where the differentiation of esophageal pH—that is, episodes of reflux and episodes of apnea—are correlated during a 12- or a 24-hour study on these patients. Apnea was the only problem for which we did sleep studies, or extended pH monitoring, but these studies were instrumental in separating children with central apnea—that is, children who did not have their apnea for reasons of gastroesophageal reflux—from those who had their apnea during episodes of reflux with low esophageal pH.