



Gastric transposition in children

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KEYWORDS

Esophageal replacement;
Gastric transposition

PURPOSE: To analyze the outcome in 192 children (116 males, 76 females) undergoing transposition since 1981.

METHODS: The most common indications for esophageal replacement included failed repair of different varieties of esophageal atresia (138), caustic injury (29), and peptic strictures (9). A total of 81% of the patients were referred from other hospitals (50% from other countries). Age at operation ranged from 7 days to 17 years. The gastric transposition was performed by using blunt mediastinal dissection in 98 patients, with an additional 90 patients undergoing lateral thoracotomy. The retrosternal position was used in 4 patients.

RESULTS: There were no graft failures, including those who had previously had failed gastric tube or Scharli operations. Anastomotic leaks occurred in 12% (all but one resolved spontaneously). Anastomotic stricture, requiring dilation developed in 20%. Half of these patients had previously sustained caustic esophageal injury. There were 9 deaths in the group (4.6%). One death occurred intraoperatively, 5 in the early postoperative period, and there were 3 late deaths. In over 90% of our patients, the outcome was considered good to excellent in terms of absence of swallowing difficulties or other gastrointestinal symptoms. Many children preferred to eat small frequent meals. Poor outcome was particularly associated with multiple previous attempts at esophageal salvage. There was no deterioration in the function of the gastric transposition in those patients followed for more than 10 years.

CONCLUSIONS: Gastric transposition for esophageal substitution is an acceptable procedure. It is attended by 4.6% mortality and a 12% leak rate. A total of 20% of the patients needed anastomotic dilation for stricture. In the long term, good function has been maintained. Gastric transposition compares favorably with other methods of esophageal replacement.

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The ideal esophageal substitute should function as closely as possible to the original structure. The patient should be able to swallow normally, consume normal amounts, and should not experience any reflux symptoms. An additional requisite in children is that the substitute should continue functioning for many years without deterioration.

Satisfactory results have been reported for all forms of esophageal replacement,¹ although the numbers reported are mostly small and long-term data are scanty.

In the past 25 years, we have used gastric transposition almost exclusively for esophageal substitution. The present report describes the outcome in the largest number of children undergoing this procedure to date.

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Materials and methods

In the 25-year period, 1981 to 2005, 192 infants and children underwent gastric transposition for esophageal substi-

Table 1 Indication for esophageal replacement

Esophageal atresia	138
With distal tracheoesophageal fistula	76
Isolated atresia	48
With proximal fistula	12
H-fistula	2
Caustic stricture	29
Peptic stricture	9
Other	16
Achalasia	2
Laryngeal cleft	2
Congenital amotile esophagus	2
Congenital stenosis	3
Congenital short esophagus	1
Prolonged foreign body impaction	2
Diffuse leiomyoma	2
Inflammatory pseudo-tumour	1
Teratoma	1

tution. There were 116 male and 76 female patients undergoing the procedure at a median age of 2 years (range 7 days to 17 years).

The indications for esophageal replacement are shown in Table 1. Ninety-four patients were referred from centers abroad (49%), 62 from centers within the United Kingdom (32%), and the remaining 36 (19%) received all their treatment at Great Ormond Street Hospital.

A prior colonic interposition had been unsuccessful in 17 patients, a partial gastric transposition in 6, 3 each had had a Scharli-type procedure² or a reversed gastric tube esophagoplasty, and 1 child had a failed jejunal interposition. Previous extensive surgical attempts to retain the original esophagus had been performed in a total of 69 (36%) patients.

The method of replacement was via the posterior mediastinum using blunt dissection in 98 patients, whereas 90 patients required an additional lateral thoracotomy due to extensive mediastinal fibrosis secondary to the original injury (caustic, perforation) or to previous attempts at esophageal reconstruction. The stomach was placed in the retrosternal position in 4 patients, who previously had a failed colonic interposition placed in that site. The surgical technique has been fully described previously.^{3,4} A jejunal feeding tube was routinely inserted in patients who had not previously fed orally. A transanastomotic nasogastric tube was left in the intrathoracic stomach to provide postoperative gastric decompression. All patients with the exception of the first 9 in the series were electively paralyzed and mechanically ventilated for varying periods postoperatively.

Ethical committee approval was obtained for this study as was approval from the Hospital Research & Development Committee.

Results

There were nine deaths in the series, for a mortality rate of 4.6%. One child died intraoperatively from uncontrollable

hemorrhage, five died in the early postoperative period from either respiratory (4) or cardiac (1), failure and three died over a year postoperatively. Eight of these children had had complex courses before the transposition (Table 2).

The median time on mechanical ventilation postoperatively was 4 days (range 0-120 days). The patient requiring 120 days of mechanical ventilation had a complete laryngotracheal cleft repaired 6 months before the gastric transposition.

Anastomotic leakage at the esophagogastric connection occurred in 23 patients (12%), all except 1 of which closed spontaneously. The 1 child with a major disruption had a cervical esophagostomy reestablished. Secondary anastomosis was performed 6 months later. Four of these patients had undergone previous unsuccessful esophageal replacement procedures (2 colonic and 2 partial gastric transposition), and 9 had had multiple procedures performed previously in an attempt to preserve their original esophagus.

Anastomotic strictures developed in 40 patients (20%), with all but 3 responding to endoscopic dilatations. In the 3 requiring stricture resection, the procedure was successfully completed via a cervical approach. In 17 cases the original pathology was caustic esophageal injury. Five children had previously undergone a colonic interposition.

Significant swallowing problems were encountered postoperatively in 55 patients (29%), half of whom had prolonged difficulties. Eighteen of these children had had major swallowing problems before the gastric transposition.

Severe delay in gastric emptying occurred as a late complication in 16 (8.3%) patients. Included among this group were 3 infants in whom an original pyloromyotomy was converted to a pyloroplasty and 2 who required a Roux-en-Y gastrojejunostomy.

Seven patients experienced problems with the jejunal feeding tube comprising leakage into the peritoneal cavity following traumatic reintubation, volvulus, intussusception, internal fistula, and adhesion obstruction.

Other complications included three infants with severe tracheomalacia, two of whom required aortopexy, two vocal cord paresis requiring temporary tracheostomy, two chylous effusions, two transient Horner's syndrome, and one postoperative hemorrhage requiring rethoracotomy.

The long-term outcome was considered excellent if the child had normal eating habits with an absence of symp-

Table 2 Postoperative complications following gastric transposition

Mortality	9	(4.6%)
Anastomotic leak	21	(12%)
Anastomotic stricture	34	(19.6%)
Significant swallowing problems	53	(30.6%)*
Delayed gastric emptying	15	(8.7%)
Jejunal tube complication	7	(4%)
Dumping syndrome	5	(2.9%)
Others	13	(7.5%)

*All except 8 improved in the long-term follow-up.

toms. The result was considered good if the child had occasional dysphagia or had an altered eating habit, such as a preference for a small, frequent meal. In 90% of our patients, the long-term outcome was considered good to excellent in terms of absence of swallowing difficulties or other gastrointestinal symptoms, such as dumping or diarrhea. Many patients prefer to eat small frequent meals. Unsatisfactory long-term outcome was present in 8 patients (4.6%), 3 of whom had chronic respiratory problems (CHARGE syndrome, laryngeal cleft, recurrent pneumonia). A poorer outcome was particularly associated with multiple previous attempts at esophageal salvage. There was no evidence of deterioration in the function of the gastric transposition in 72 patients followed up for longer than 10 years.

Where information was available, height centiles follow a normal distribution, whereas weights average around the 25th centile for age.

Discussion

Our initial experience with gastric transposition at Great Ormond Street Hospital suggested that the outcome was superior to a group who had undergone colonic interposition.⁵ We were by no means the first to use this operation,^{6,7} but because of the referral pattern of the hospital, we encountered a large number of children requiring esophageal replacement. In total, 156 (81%) of our patients came from other centers.

Although we certainly subscribe to the principle that the child's own esophagus is best and that the esophagus can be preserved in a majority of cases,⁸⁻¹⁰ we remain concerned that, in some cases, repeated attempts to preserve the esophagus may be to the detriment of the child and that their own esophagus may be a liability. In many of these children, their entire infancy and early childhood had been dominated by endless attempts to preserve the native esophagus at all costs.

Our preferred approach is to use the posterior mediastinal route, developed by blunt dissection from below via the hiatus and from above through the cervical incision.^{3,4} In many children, this maneuver is accomplished without difficulty. This applies particularly to those who had had no previous surgery or sepsis in the mediastinum. Esophagectomy without thoracotomy is usually possible after caustic injury, as much of the dissection may be performed under direct vision. Nonetheless, with this technique, there is a phase where blind finger dissection is necessary. The guide for this phase of dissection is the spine, and the surgeon's fingers should remain in contact with the vertebra. If firm fibrous tissue is encountered, due to previous surgery or esophageal perforation, we would recommend early recourse to thoracotomy and dissection of the esophagus under direct view.

A few of our patients had failure of reversed gastric tube or Schlari-type procedure.² Although we were concerned

about the viability of the stomach under these circumstances, no problems were encountered. We assume that, in the intervening time since the original reconstruction, the blood supply to the stomach had adjusted such that it could be transposed on the right gastric or right gastroepiploic artery alone.

Significant swallowing problems were encountered in a third of our patients, most of whom were born with esophageal atresia. The importance of sham feeding in this group in maintaining a normal swallowing mechanism cannot be overemphasized. The feeding difficulties can persist for many months, during which enteral nutrition is provided by jejunal feeds, but improvement gradually occurs. In the long term, the great majority of patients can eat and swallow normally. Although many prefer small, frequent meals, those who have undergone esophageal replacement in later childhood report a normal feeling of satiety after eating.¹¹

We have previously reported on the longer term nutritional and respiratory function.¹² Although the few children tested have a measurable respiratory compromise, they are generally asymptomatic. Whereas most of our patients were in the lower centiles for weight, their heights remain within the normal range; we were unclear whether this was related to their underlying problem or to the operation. Children who had caustic injury followed their previous percentiles.

It remains to be determined whether Barratt's metaplasia in the proximal esophagus will be a longer term problem. We have not encountered this so far, but are aware of the problem when gastric tubes are used.¹³ As the stomach has been vagotomized, the amount of acid produced may be insufficient to induce metaplasia. A few children have reported symptomatic reflux at night and sleep with several pillows.

We remain unsure of the best approach for those with CHARGE association, complete laryngeal clefts, and caustic injuries to the upper esophagus and pharynx, as bolus gastrostomy feeds are more preferable in these children. Colonic interposition may be a better option under these circumstances.

A mortality rate of 5.2% is a concern after any operation. Respiratory failure (4) was the most common cause of death, but it is unclear whether an alternative procedure would have altered the outcome. Eight of the nine patients had undergone many previous operations¹⁴ and were compromised from a respiratory aspect. A bulky stomach in the chest of a child with borderline lung function may be a problem and, under certain circumstances, may not be the optimal esophageal substitute.

We believe that mortality can be reduced by submitting patients to esophageal substitution earlier and refraining from endless attempts at esophageal salvage. It is easy to become unduly focused on saving the esophagus at all costs, and repeated attempts at esophageal salvage will substantially increase the operative difficulty encountered at the time of esophageal substitution.

We are encouraged that, at least after the first decade, there is no symptomatic deterioration in function of the transposed stomach.

Gastric transposition has replaced colonic interposition as the esophageal replacement procedure of choice in many centers.¹⁵⁻¹⁷ The excellent blood supply of the stomach, the fact that only one anastomosis is required, and the relative technical ease of the procedure are clear advantages. In addition, the long-term follow-up of our patients has shown good growth and development, and the function of the replacement should continue to be satisfactory in the immediate future.

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