Oesophageal replacement in children

GS ARUL, D PARIKH

Department of Paediatric Surgery, Birmingham Children's Hospital, Birmingham, UK

ABSTRACT

INTRODUCTION The usual indications for oesophageal replacement in childhood are intractable corrosive strictures and long-gap oesophageal atresia. Generally, paediatric surgeons attempt to preserve the native oesophagus with repeat dilatations. However, when this is not successful, an appropriate conduit must be fashioned to replace the oesophagus. The neo-oesophagus should allow normal oral feeding, not have gastro-oesophageal reflux, and be able to function well for the life-time of the patient.

PATIENTS AND METHODS A Medline search for oesophageal replacement, oesophageal atresia, gastric transposition, colon transposition, gastric tube, caustic stricture was conducted. The commonest conduits including whole stomach, gastric tube, colon and jejunum are all discussed.

RESULTS No randomised controlled studies exist comparing the different types of conduits available for children. The techniques used tend to be based on personal preference and local experience rather than on any discernible objective data. The biggest series with long-term outcome are reported for gastric transposition and colon replacement. Comparison of a number of studies shows no significant difference in early or late complications. Early operative complications include graft necrosis, anastomotic leaks and sepsis. Late problems include strictures, poor feeding, gastro-oesophageal reflux, tortuosity of the graft and the development of Barrett's oesophagus. The biggest series, however, seem to have lower complications than small series probably reflecting the experience, built up over years, in their respective centres.

CONCLUSIONS Long-term follow-up is recommended because of the risks of late strictures, excessive tortuosity of the neo-oesophagus and the development of Barrett's oesophagus.

KEYWORDS

Oesophagus – oesophageal atresia – caustics – oesophageal stenosis – oesophagoplasty

CORRESPONDENCE TO

DH Parikh, Consultant Paediatric General & Thoracic Surgeon, Department of Surgery, Birmingham Children's Hospital, Steelhouse Lane, Birmingham B4 6NH, UK
T: +44 (0)121 333 8084; E: dakshesh.parikh@bch.nhs.uk

The usual indications for oesophageal replacement in childhood are intractable corrosive strictures¹ and long-gap oesophageal atresia.² Oesophageal replacement in childhood is one of the major surgical challenges and is undertaken mainly for benign conditions (see Table 1)^{1,2} unlike adults where malignant conditions predominate.³ Most paediatric surgeons follow an axiom that the best oesophageal conduit is the native oesophagus; hence, they only consider reconstruction in the failures. Significant sequelae are known to occur due to over-zealous attempts to conserve the native oesophagus, including feeding difficulties, dysphagia and numerous dilatations causing problems with the mandible, temporomandibular joint and teeth.² Social and psychological problems also occur as a result of lack of normal diet or swallow, several hospital admissions causing disruption of school education, family life, loss of parenteral jobs and needle phobia from

numerous anaesthetics and blood tests. Carcinoma of the oesophagus 20–40 years after caustic ingestion is well described.⁴

The first reported oesophageal reconstruction was in 1877 by Czerny,⁵ followed by a successful oesophagus replacement with a subcutaneous skin tube over the sternum in an adult.⁶ Paediatric skin tube oesophageal replacement was performed in stages by Ladd and Gross to bridge the long-gap in the rare survivors of oesophageal atresia.⁷ However, this technique soon became obsolete due to improved safety and surgical innovation allowing intrathoracic oesophageal surgery.

Various oesophageal replacements were used, including jejunum by Roux⁸ in 1907, a gastric tube by Gavriliu⁹ and a gastric pull-up to replace the entire oesophagus by Sweet in 1947.¹⁰ Colon replacement was first successfully used by Dale for children in 1955.¹¹ Other methods using synthetic tubular prosthesis for oesophageal replacement were also

Table 1 Indications of oesophageal replacement in children

1. Oesophageal atresia
 - Long-gap oesophageal atresia where delayed primary anastomosis is unlikely
 - Anastomotic disruption requiring oesophagostomy
 - Prematurity and respiratory distress precluding primary anastomosis
 - Severe anastomotic stricture unresponsive to dilatation
2. Corrosive stricture not responsive to repeated dilatations
3. Malignancy – Very rare in childhood these include leiomyosarcoma, teratoma and inflammatory pseudotumour²
4. Indications for which oesophageal replacement was performed in the past such as oesophageal varices, severe oesophageal candidiasis in immunologically compromised children and neglected peptic stricture are now obsolete because of early recognition of problems and advances in management.

attempted without success.^{12–14} The ideal features of the replacement oesophagus are summarised in Table 2.

Patients and Methods

A Medline search was performed for a number of childhood conditions that would require oesophageal replacement – oesophageal atresia with or without tracheo-oesophageal fistula, caustic and peptic strictures, as well as for the most commonly used oesophageal replacements such as the whole stomach, gastric tube, colon and jejunum. In this article, the advantages and disadvantages of each type of conduit are considered and the published results discussed.

Figure 1 Gastric transposition (note a pyloroplasty has been done).

Results

Gastric transposition

The gastric pull-up involves mobilisation of the entire stomach on a vascular pedicle, creating a space in the mediastinum and achieving an anastomosis in the neck with the cervical oesophagus (Fig. 1).^{15,16} The entire stomach with its blood supply is pulled up through the oesophageal hiatus in the posterior mediastinum so that oesophagogastric anastomosis can be performed in the neck. Occasionally, the gastric pull-up is performed through the retrohilar route.¹⁷ Many surgeons now also advocate a pyloroplasty as a drainage procedure.

Stomach replacement has advantages of having a single anastomosis in the neck or mediastinum, a very good blood supply and can replace the whole length of the oesophagus with a low theoretical risk of necrosis, anastomotic leak and stricture.

Table 2 Requirements for the ideal oesophageal conduit

- Allows normal feeding
- Permits replacement of the entire oesophagus when indicated
- Does not cause respiratory compromise
- Does not become tortuous or redundant
- Gastro-oesophageal reflux in the conduit should be minimal
- Does not have increased malignant risk
- Should function normally for the life-time of the individual (i.e. over 70 years)
- Should be technically adaptable for small children
- Replacement results should be reproducible by different surgeons

Critics of this approach claim that the stomach occupies a large space in the chest of small children and has a potential for causing significant respiratory compromise. It could also be a source of recurrent aspirations from gastro-oesophageal reflux. In addition, vagotomy is a universal effect of this operation and may lead to delayed gastric emptying and dumping.

In a large, single-centre series reported by Spitz and colleagues² with 173 patients having gastric pull-up over a 21-year period, there were no graft failures. They reported 9 deaths (5.2%); one intra-operative, five in the early postoperative period and three late deaths. Anastomotic leaks occurred in 21 patients (12%) of which 11 resolved spontaneously. Anastomotic strictures requiring dilatation occurred in 19.6%. Marujo *et al.*¹⁵ reported 21 patients with gastric transposition with one death, four leaks and two patients with significant long-term problems of regurgitation and poor gastric emptying. Overall, functional outcome in these series was excellent.

A manometric evaluation of the intrathoracic stomach found that it was not simply an inert conduit but showed evidence of mass contractions without having any obvious rhythmic peristaltic contractions.¹⁸ A long-term physiological follow-up of 17 patients with gastric transposition showed that 13 had a normal height and weight and 16 had a normal diet.¹⁹ Despite the fact that only four children complained of dyspnoea, all but one had evidence of reduced lung function tests with an average lung capacity of 68% of predicted.¹⁹ The authors concluded from this study that gastric transposition allowed for normal feeding and growth. However, anecdotal reports suggest that a number of patients undergoing gastric pull-up in the 1960s required

colon transposition in the 1980s because of lung problems associated with chronic acid reflux, aspiration pneumonitis and compression by the dilated intrathoracic stomach.²⁰

Gastric tube

The gastric tube is constructed from the greater curve of the stomach with blood supply from the left gastro-epiploic artery. It was traditionally described as a reversed (anti-peristaltic) gastric tube²¹ though, more recently, refinements in the technique have made it possible to use an isoperistaltic tube.^{22,23}

The main steps of the operation are shown in Figure 2 and involve first dividing the gastrosplenic omentum, the right gastro-epiploic artery (Fig. 2A) and the short gastric vessels. A gastric tube is constructed from the greater curve either using a GIA stapler or with a hand-sewn anastomosis around a catheter 18–24-Fr tube. Care must be taken to

Figure 3 Colon interposition (a pyloroplasty has been done).

avoid kinking the gastric tube when it is brought into the chest, preferably through the oesophageal hiatus (Fig. 2B). The anastomosis with the proximal oesophagus is performed in a single layer either in the neck or in the chest depending on the length of the proximal normal oesophagus. The cervical end should be drained; a trans-anastomotic nasogastric tube and a feeding gastrostomy are also performed.

The gastric tube has an excellent and reliable blood supply, it is resistant to ulceration from gastric acid reflux and has the ability to bridge long gaps.²⁴ Furthermore, the gastric tube retains its tubular shape without developing tortuosity and dilatation even though it appears to act purely as a passive conduit.²⁵ Theoretical disadvantages include a long suture length, a reduced stomach capacity and continued acid production by the tube.

Two series using this technique with 11 and 34 patients, respectively, showed at least a 50% cervical leak rate and a 66% stricture rate.^{21,25} However, long-term follow-up in these cases showed that, eventually, most had good swallowing with a relatively normal diet though small meals and 'grazing' (possibly due to the small residual stomach) appeared to be common.²⁰ A recent series of 21 isoperistaltic tubes showed no deaths and only two oesophagogastric leaks. However, only 13 of these patients had a completely normal diet, two had severe dysphagia and three required a feeding jejunostomy.²² In adults, a comparative study of over 200 patients concluded that transposition of the whole stomach had benefits over the gastric tube because there was no loss of stomach volume and the blood supply was better.²⁶

Scharli and colleagues²⁷⁻²⁹ have described a technique for elongation of the lesser gastric curve to allow oesophageal replacement without the need for fashioning a tube. The

technique appears an elegant means of preserving some native oesophagus and the oesophagogastric junction. However, complications do occur frequently, possibly as a consequence of the degree of devascularisation consequent upon division of the gastric artery. There are no long-term follow-up studies of this technique in children.

Colon transposition

Colon, on its vascular pedicle, is the most frequently used conduit for the oesophagus; the transverse, ascending or descending colon have been used, in either an antiperistaltic or isoperistaltic fashion.

The most commonly performed method involves mobilising the colon and preparing a graft based on the left colic artery (Fig. 3). The oesophagus is resected, if required, prior to transposition. The colon is pulled up into the neck and an end-to-side or end-to-end oesophagocolic anastomosis is done in the neck; the gastrocolic anastomosis is done at the cardia with an anti-reflux wrap of the stomach. Finally, a pyloroplasty is done and a mediastinal drain is left *in situ*.³

Colon interposition is relatively easy to perform and is readily accommodated without causing respiratory compromise in a child. Overflow from the colon into the trachea is rare. Disadvantages are: (i) the need for three anastomoses; (ii) increased risk of anastomotic leak; and (iii) strictures at the proximal oesophagocolic anastomosis due to poor vascularity. Redundancy, tortuosity and dilatation of the colonic conduit can develop in the long term. Colon may be an unsuitable conduit in the presence of an associated anorectal malformation where a colostomy was initially performed before reconstruction of the anus.

Recently, Hamza *et al.*¹ reported a 30-year experience of 775 patients of colonic interposition mainly in patients with caustic strictures rather than oesophageal atresia. They reported a 10% cervical leak rate, 5% proximal strictures, 2% postoperative obstruction and 1% mortality. These results are much better than the average published studies^{20,30,31} that report a cervical leak rate of 30–60% and may reflect their extensive experience. Their preferred option is now to use the left colon based on the left colic vessels through the posterior mediastinal route with an antireflux wrap of the stomach.¹

In the long term, redundancy developed in 3%³ to 12%³² of patients. The dilatation and tortuosity of the colonic conduit in the chest is believed to be due to negative pressure in the thoracic cavity and its passive nature, emptying essentially by gravity.^{33,34} This complication can be reduced by avoiding a breach in the pleura and resecting excess colon at the cervical end prior to anastomosis. Hamza *et al.*¹ reduced this problem by using the posterior mediastinal route (0.9%) instead of the retrosternal route (2.7%) – presumably related to the shorter and straighter course of the colonic conduit.

Other risks include colonic ulceration as a consequence of chronic gastrocolic reflux. Rodgers *et al.*³⁴ assessed eight chil-

dren for the long-term functional and metabolic consequences of this operation. Four had evidence of iron-deficiency anaemia and, as the ileocolic region had been used in their series, three had evidence of vitamin B₁₂ deficiency.³⁴

Small bowel interposition

Several techniques have been tried using jejunum or ileum either on its pedicle^{35,36} or as a free graft.³⁷ Ring *et al.*³⁵ described a pedicle jejunal interposition for the oesophagus done over 3 or 4 stages with illustration of some elegant methods for preventing redundancy and gaining extra length; these included making radial incisions in the peritoneum and dividing vascular arcades to allow curves in the jejunum to be straightened. Ileal interposition was described by Bax and Van Renterghem³⁸ in which the right colon is sacrificed to allow a longer mesenteric pedicle to the terminal ileal graft.

Ring *et al.*³⁵ reported excellent results with low morbidity and mortality using a jejunal pedicle graft interposition in 32 patients, probably due to their meticulous technique and staged approach. The complications in this series (in 16 that reached adulthood) included four children with cervical leaks that healed spontaneously, one requiring revision of the distal tip of the graft and one needing dilatation of the cervical stricture. All their patients could eat a regular diet at a normal speed and motility of the jejunal limb was normal in 12 of the 13 patients studied.

Saeki *et al.*³⁶ reported on 19 patients following jejunal interposition as a single stage procedure in which the lower oesophageal sphincter mechanism was preserved. There were three major early complications of graft necrosis, perforation and anastomotic leaks and two deaths. Long-term follow-up of 12 patients revealed two strictures requiring dilatation, redundancy needing revision in one, and seven with transient stagnation at the level of the lower oesophagus. Eleven of the 12 patients had normal feeding and none were suffering from reflux.

Others have also tried to get around the technical problems of the precarious blood supply by either augmenting the existing blood supply, or by using a free graft, with a microvascular anastomosis to the internal mammary artery.^{37,39} However, significant complications, including death, are a major risk due to graft necrosis, ischaemia and strictures.

Risks of Barrett's oesophagus

Barrett's oesophagus is the endoscopic and histological findings of columnar mucosa within the oesophagus and is known to predispose to adenocarcinoma. With the long-term success of oesophageal replacement there is an increasing awareness of the risks of Barrett's oesophagus. Unfortunately, although Barrett's oesophagus is tightly defined,⁴⁰ there is rarely any reference to the criteria used for diagnosis in the paediatric literature.

Isoperistaltic gastric tube interposition have been shown to secrete acid in 9 of 21 patients and two had Barrett's oesophagus above the cervical anastomosis.²² Long-term endoscopic follow-up in a series of 14 patients with gastric pull up, showed 10 cases with Barrett's changes.⁴¹ Hamza *et al.*¹ reported 10 cases of Barrett's oesophagus and one carcinoma in the upper oesophagus in 75 patients after gastric pull-up procedure. However, Spitz *et al.*,² in their 21-year follow-up of 173 patients, did not see a single case possibly due to vagotomy and drainage procedure (pyloroplasty).

Barrett's oesophagus appears to be less of a problem in colonic transposition. In a series of 475 patients undergoing colonic transposition, there were 15 cases of gastrocolic acid reflux (all in the retrosternal group) and no cases of Barrett's oesophagus.⁵ Khan *et al.*⁴² and Rodgers *et al.*,³⁴ in their small series, described only two cases of having acid reflux without evidence of Barrett's oesophagus in their colonic transpositions. Barrett's oesophagus is also a problem in the bypassed unused oesophageal segment; Shamberger *et al.*⁴³ found Barrett's changes in three of their eight patients.

Discussion

We have identified in this brief review that a number of oesophageal replacement techniques are available, but none fully replicates the features of a normal oesophagus. Hence, although it may appear sensible to preserve the native oesophagus, excessive attempts at this may ultimately prove detrimental to the child and family. It is recognised that, regardless of the technique chosen, the native unused and diseased oesophagus should be removed due to risks of Barrett's oesophagus or carcinoma. Current practice of the posterior mediastinal route of the oesophageal replacement has allowed better swallowing and reduced the risk of developing tortuosity.¹

As there are no randomised control trials, most retrospective series comparing two types of oesophageal replacement reflect either selection or a change in practice.^{26,44,45} The long-term outcomes of various available techniques of oesophageal replacement in children in the published retrospective studies are similar. The only published series in children with oesophageal atresia⁴⁶ compared replacements in a group of 24 British children with colon transposition with a group of 15 American children with a gastric tube and found no difference in nutrition, growth, patient acceptability, or complications; most children fell at or below the 10th centile for height and weight. It does appear, however, that the best published results have come from those centres with large numbers of cases thus reflecting the experience and dedication of the surgeons involved in pioneering and championing their techniques.

Long-term follow-up of these children is essential because of gradual changes in the function of the graft, strictures at the anastomosis and the unknown risks of Barrett's oesophagus.

References

- Hamza AF, Abdelhay S, Sherif H, Hasan T, Soliman H, Kabesh A *et al*. Caustic esophageal strictures in children: 30 years' experience. *J Pediatr Surg* 2003; **38**:828–33.
- Spitz L, Kiely E, Pierro A. Gastric transposition in children – a 21-year experience. *J Pediatr Surg* 2004; **39**: 276–81.
- Myers NA. The history of esophageal surgery: pediatric aspects. *Pediatr Surg Int* 1997; **12**: 101–7.
- Kim YT, Sung SW, Kim JH. Is it necessary to resect the diseased esophagus in performing reconstruction for corrosive esophageal stricture? *Eur J Cardiothorac Surg* 2001; **20**: 1–6.
- Czerny V. Neue Operationen. *Zentralblatt Chir* 1877; **4**: 443.
- Bircher E. Ein Beitrag zur plastischen bildung eines neuen oesophagus (A contribution to the surgical or plastic reconstruction of a new oesophagus). *Zentralblatt Chir* 1907; **51**: 1479.
- Gross RE. *The Surgery of Infancy and Childhood*. Philadelphia, PA: W.B. Saunders, 1953.
- Yudin SS. The surgical construction of 80 cases of artificial esophagus. *Surg Gynaecol Obstet* 1944; **78**: 561.
- Gavrilu D. Replacement of the esophagus by a reverse gastric tube. *Curr Problems Surg* 1975; **12**: 36–64.
- Sweet RH. Subtotal esophagectomy with high intrathoracic esophago-gastric anastomosis in the treatment of extensive cicatricial obliteration of esophagus. *Surg Gynaecol Obstet* 1947; **83**: 417.
- Dale WA, Sherman CD. Late reconstruction of congenital oesophageal atresia by intrathoracic colon transplantation. *J Thorac Cardiovasc Surg* 1955; **29**: 344.
- Salama FD. Prosthetic replacement of the esophagus. *J Thorac Cardiovasc Surg* 1976; **70**: 739.
- Lister J, Altman RP, Allison WA. Prosthetic substitution of the thoracic esophagus in puppies. *Ann Surg* 1965; **162**: 812.
- Berman EF. Plastic oesophagus. *Sinai Hosp J* 1952; **1**: 40.
- Marujo WC, Tannuri U, Maksoud JG. Total gastric transposition: an alternative to esophageal replacement in children. *J Pediatr Surg* 1991; **26**: 676–81.
- Spitz L, Kiely E, Sparnon T. Gastric transposition for esophageal replacement in children. *Ann Surg* 1987; **206**: 69–73.
- Spitz L. Gastric transposition for oesophageal replacement. *Pediatr Surg Int* 1996; **11**: 218–20.
- Gupta DK, Charles AR, Srinivas M. Manometric evaluation of the intrathoracic stomach after gastric transposition in children. *Pediatr Surg Int* 2004; **20**: 415–8.
- Davenport M, Hosie GP, Tasker RC, Gordon I, Kiely EM, Spitz L. Long-term effects of gastric transposition in children: a physiological study. *J Pediatr Surg* 1996; **31**: 588–93.
- Newman KD, Anderson KD. Esophageal replacement. In: Stringer MD, Mouriquand PDE, Oldham KT, Howard ER. (eds) *Pediatric Surgery and Urology: Long term outcomes*. London: W.B. Saunders, 1998; 214–9.
- Randolph JG. The gastric tube for esophageal replacement in children. *Pediatr Surg Int* 1996; **11**: 221–3.
- Borgnon J, Tounian P, Auber F, Larroquet M, Boeris Clemen F, Girardet JP *et al*. Esophageal replacement in children by an isoperistaltic gastric tube: a 12-year experience. *Pediatr Surg Int* 2004; **20**: 829–33.
- Ein SH. Gastric tubes in children with caustic esophageal injury: a 32-year review. *J Pediatr Surg* 1998; **33**: 1363–5.
- Anderson KD, Randolph JG. Gastric tube interposition: a satisfactory alternative to the colon for esophageal replacement in children. *Ann Thorac Surg* 1978; **25**: 521–5.
- Randolph JG, Anderson KD. Replacement of the esophagus. In: Ravitch MM, Welch KJ, Benson CD, Aberdeen E, Randolph JG. (eds) *Pediatric Surgery*. Chicago, IL: Year Book Medical Publishers, 1979; 482–9.
- Collard JM, Tinton N, Malaise J, Romagnoli R, Otte JB, Kestens PJ. Esophageal replacement: gastric tube or whole stomach? *Ann Thorac Surg* 1995; **60**: 261–6, discussion 267.
- Fernandez MS, Gutierrez C, Ibanez V, Lluna J, Barrios JE, Vila JJ *et al*. Long-gap esophageal atresia: reconstruction preserving all portions of the esophagus by Scharli's technique. *Pediatr Surg Int* 1998; **14**: 17–20.
- Scharli AF. Esophageal reconstruction in very long atresias by elongation of the lesser curvature. *Pediatr Surg Int* 1992; **7**: 101.
- Scharli AF. Esophageal reconstruction by elongation of the lesser gastric curvature. *Pediatr Surg Int* 1996; **11**: 214–7.
- Erdogan E, Emir H, Eroglu E, Danismend N, Yeker D. Esophageal replacement using the colon: a 15-year review. *Pediatr Surg Int* 2000; **16**: 546–9.
- Ahmad SA, Sylvester KG, Hebra A, Davidoff AM, McCrane S, Stafford PW *et al*. Esophageal replacement using the colon: is it a good choice? *J Pediatr Surg* 1996; **31**: 1026–30, discussion 1030–1.
- Hendren WH, Hendren WG. Colon interposition for esophagus in children. *J Pediatr Surg* 1985; **20**: 829–39.
- Dantas RO, Mamede RC. Motility of the transverse colon used for esophageal replacement. *J Clin Gastroenterol* 2002; **34**: 225–8.
- Rodgers BM, Talbert JL, Moazam F, Felman AH. Functional and metabolic evaluation of colon replacement of the esophagus in children. *J Pediatr Surg* 1978; **13**: 35–9.
- Ring WS, Varco RL, L'Heureux PR, Foker JE. Esophageal replacement with jejunum in children: an 18 to 33 year follow-up. *J Thorac Cardiovasc Surg* 1982; **83**: 918–27.
- Saeki M, Tsuchida Y, Ogata T, Nakano M, Akiyama H. Long-term results of jejunal replacement of the esophagus. *J Pediatr Surg* 1988; **23**: 483–9.
- Cusick EL, Batchelor AA, Spicer RD. Development of a technique for jejunal interposition in long-gap esophageal atresia. *J Pediatr Surg* 1993; **28**: 990–4.
- Bax NM, Van Renterghem KM. Ileal pedicle grafting for esophageal replacement in children. *Pediatr Surg Int* 2005; **21**: 369–72.
- Cauchi JA, Buick RG, Gornall P, Simms MH, Parikh DH. Oesophageal substitution with free and pedicled jejunum: short and long-term outcomes. *Pediatr Surg Int* 2007; **23**: 11–9.
- Watson A, Heading R, Sheppard N. *Guidelines for the diagnosis and management of Barrett's columnar lined oesophagus*. A report of the working party of the British Society of Gastroenterology 2005 <http://www.bsg.org.uk/pdf_word_docs/Barretts_Oes.pdf>.
- Lindahl H, Rintala R, Sariola H, Louhimo I. Cervical Barrett's esophagus: a common complication of gastric tube reconstruction. *J Pediatr Surg* 1990; **25**: 446–8.
- Khan AR, Stiff G, Mohammed AR, Alwafi A, Ress BI, Lari J. Esophageal replacement with colon in children. *Pediatr Surg Int* 1998; **13**: 79–83.
- Shamberger RC, Eraklis AJ, Kozakewich HP, Hendren WH. Fate of the distal esophageal remnant following esophageal replacement. *J Pediatr Surg* 1988; **23**: 1210–4.
- Mansour KA, Bryan FC, Carlson GW. Bowel interposition for esophageal replacement: twenty-five-year experience. *Ann Thorac Surg* 1997; **64**: 752–6.
- Lindahl H, Louhimo I, Virkola K. Colon interposition or gastric tube? Follow-up study of colon-esophagus and gastric tube-esophagus patients. *J Pediatr Surg* 1983; **18**: 58–63.
- Anderson KD, Noble H, Belsey R, Randolph JG. Long-term follow-up of children with colon and gastric tube interposition for esophageal atresia. *Surgery* 1992; **111**: 131–6.