NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE

INTERVENTIONAL PROCEDURES PROGRAMME

Interventional procedure overview of the Foker technique for long-gap oesophageal atresia

Introduction

This overview has been prepared to assist members of the Interventional Procedures Advisory Committee (IPAC) in making recommendations about the safety and efficacy of an interventional procedure. It is based on a rapid review of the medical literature and specialist opinion. It should not be regarded as a definitive assessment of the procedure.

Date prepared

This overview was prepared in October 2005.

Procedure names

- Foker technique.
- Delayed oesophageal anastomosis following traction.

Specialty societies

- British Association of Paediatric Surgeons.
- British Society of Paediatric Gastroenterology Hepatology and Nutrition.

Description

Indications

Oesophageal atresia is a congenital condition in which there is a break in the continuity of the oesophagus between the mouth and stomach at birth. Both the proximal and distal ends of the oesophagus end in pouches; or more commonly either end of the oesophagus maybe attached to the trachea to form a tracheo-oesophageal fistula (TOF). TOF occurring in about 1 in 3500 births, pure oesophageal atresia accounts for only 9% of cases. 50% of infants will have other associated congenital abnormalities. Saliva and milk are unable to reach the stomach pooling in the mouth and upper airway and passing though the tracheo-oesophageal fistula into the lungs; this results in episodes of choking, coughing and cyanosis leading to aspirated pneumonia. If untreated the condition is fatal with death from pneumonia or malnutrition. The length of the atresia can vary from a few millimetres

to a few centimetres. Definition of long gap atresia varies but tends to describe cases in which the gap is greater than 3 or 3.5 cm

Current treatment and alternatives

Initial management is to keep the airway clear, provide intravenous nutrition and exclude additional major abnormalities. The vast majority are treated by surgical division of the fistula and primary anastomosis of the oesophagus enabling normal swallowing. Feeding is commenced via a transanastomotic nasogastric tube or by mouth.

With long gap atresia the anastomosis is more difficult as the join is placed under significant tension. Initial surgery is undertaken to divide any fistula present and site a gastrostomy to enable enteral feeding to be established. Repair is delayed by a period of up to 3 months to allow the upper and lower pouches to elongate and hypertrophy with the hope that anastomosis will be possible. During this time the upper pouch must be keep clear of secretions. If delayed primary anastomosis is not possible alternative surgical approaches include; gastric pull-up to bring the stomach partially into the thorax, and the use of organic material such as a piece of colon to join up the oesophageal ends. Gastro-oesophageal reflux and anastomotic stricture are common complication after all type of surgical repair however the risk is high with long gap atresia as is the risk of leakage if the join fails.

What the procedure involves

Using a transthoracic transpleural approach, the fistula or fistulae are divided and oversewn. The proximal and distal oesophageal pouches are opened and traction sutures are placed in the ends, brought out through the skin surface and fixed with a silastic buttons. Traction is applied to the sutures which stimulates elongation of the oesophagus by about 1 or 2 mm per day. Once the ends of the oesophagus have come together, or are in close proximity, a primary anastomosis is performed. The patient may be kept sedated and ventilated for a few days to allow the anastomosis to heal. Routine oesophageal balloon dilatation may be planned after repair.

Efficacy

The definitions used for clinical outcome varies considerably between studies, and were often solely qualitative. One case series reported 70 oesophageal atresia cases treated by primary repair. It contained 10 infants with long gap atresia 4 of whom were treated with the Foker technique. Length of follow up is unclear, however all 4 patients were eating excellently or satisfactorily, all 10 infants had gastro-oesophageal reflux requiring fundoplication and were more likely to suffer anastomotic stricture dilations than others with a short gap oesophageal atresia. A second series from the same group described 63 cases, 23 of which were treated with external traction, where the atresia length ranged from 3.7 to 10 centimetres. A primary anastomosis was achieved in all cases.

A case series documented that 67% (2/3) achieved full oral feeding at up to 4 months postoperatively. Another found that 50% (1/2) were eating solids normally at 1 year, whereas 50% (1/2) still required a gastric tube for feeding. The rate of anastomosis success varied between studies from 100% (10/10 and 2/2) through 50% (1/2) to 33% (1/3).

Safety

Disruption of sutures during the traction stage of the procedure occurred in 25% (3/12) of long gap atresia cases across all the studies identified, usually requiring the anastomosis to be performed under greater tension than intended. No deaths were reported directly related to repair of the oesophageal atresia however in the study of 70 patients undergoing a primary repair 11% (8 infants) died of causes not as a direct consequence of the repair surgery.

Literature review

Rapid review of literature

The medical literature was searched to identify studies and reviews relevant to Foker technique for long-gap oesophageal atresia. Searches were conducted via the following databases, covering the period from their commencement to 1 December 2004: MEDLINE, PREMEDLINE, EMBASE, Cochrane Library and Science Citation Index. Trial registries and the Internet were also searched. No language restriction was applied to the searches.

The following selection criteria (Table 1) were applied to the abstracts identified by the literature search. Where these criteria could not be determined from the abstracts the full paper was retrieved

Table 1 Inclusion criteria for identification of relevant studies

Characteristic	Criteria
Publication type	Clinical studies included. Emphasis was placed on identifying good quality studies. Abstracts were excluded where no clinical outcomes were reported, or where the paper was a review, editorial, laboratory or animal study. Conference abstracts were also excluded because of the difficulty of appraising methodology.
Patient	Long-gap oesophageal atresia.
Intervention/test	Foker technique.
Outcome	Articles were retrieved if the abstract contained information relevant to the safety and/or efficacy.
Language	Non-English-language articles were excluded unless they were thought to add substantively to the English-language evidence base.

List of studies included in the overview

This overview is based on five case series(1), multiple(2-4), or single(5) case reports

Existing reviews on this procedure

No systematic reviews or evidence-based clinical guidelines on the Foker technique in long-gap oesophageal atresia were found during literature searches.

Table 1 Summary of key efficacy and safety findings on Foker technique for long-gap oesophageal atresia

Abbreviations used: OA – oesophageal atresia,			
Study details	**Key efficacy findings**	**Key safety findings**	**Comments**
Foker J E (2005) (6) Case series USA n=63 (n=23 had external traction) 1984 – 2004 Children with an oesophageal atresia of 2.5 cm or greater. Incision made in the back. Sutures were attached to each oesophageal end and either crossed and placed in steady traction for several minutes, internal traction sutures left for 3 or 4 days, or sutures brought out of the back and attached to Silastic buttons and tension increased daily for 8 to 18 days. If gastro oesophageal reflux was present after the operation a dilation and Nissen fundoplication was undertaken in the first few days, and subsequent dilations performed every 1 to 2 weeks until structuring desisted. Age = 1 day to 5.5 years, overall artesia length = 2.6 to 12.5 cm. For external traction the atresia length ranged from 3.7 to 10 cm.	**Repair success** A satisfactory primary anastomosis was achieved in 97% (61/63) of patients. One patient is still awaiting anastomosis, and 1 died 2 days prior to scheduled primary repair, due to subdural haematoma. There was no comparison made of repair success for the temporary traction in the operating room, internal traction, or external traction technique. **Feeding** All of the cases had a mechanically satisfactory, and all swallow satisfactorily.	**Operative complications** There were no operative deaths or severe complications. **Late complications** There were no anastomotic leak nor recurrent trans oesophageal fistulae. **Reoperations** Reopening the thoracotomy site during the period of oesophageal traction was required 'on several occasions' for one or more sutures having pulled out. Interval reoperations were required for adhesions of sutures or lack of daily progress of oesophageal growth, and also to restring the sutures higher on the chest wall to allow for further growth.	Variation in technique with the specific methods being determined intraoperatively. Only ranges are provided for demographic criteria. No long term clinical outcomes statistically reported. Not stated how many cases received dilation and Nissen fundoplication. Frequency of reoperations not stated. A large proportion of the cases may be the same as in Foker (1997).

Abbreviations used: OA – oesophageal atresia,

Study details	Key efficacy findings	Key safety findings	Comments
Foker J E(1997)(1) Case series USA n = 70 with oesophageal atresia, 10 with long-gap atresia, 4 who had traction and delayed repair Infants with oesophageal atresia. Gaps were estimated from X-ray studies. Long-gap atresia defined to be > 2.5 cm Age not stated, length of atresia = 5.3 to 6.8 cm (in infants who had delayed repair) Tissue pledgetted traction sutures in upper and lower oesophageal segments brought out to skin surface and 6 to 10 days of increasing external traction until segments within 1 to 2 cm and primary repair undertaken Follow up = 8.8 years (range 2 to 19)	**Anastomosis success** All very long gap repairs showed no leaks on contrast oesophagrams No gastronomy tubes remained at 8.8 years **Secondary procedures** Across all 70 repairs 34% (24/70) of cases required fundoplication for reflux (this was required in 100% of very long gap cases), 7% (5/70) received aortopexis for tracheomalacia, 3% (2/70) required resection of strictures, and 1% (1/70) underwent a late division of an upper pouch fistula 70% (21/70) required additional dilations (more than the three planned in the protocol) for symptoms suggestive of anastomitic narrowing **Subjective assessment** Telephone interview at a mean 8.8 years found that all patients were eating satisfactorily or excellently 91% could eat anything they wished, 14% had at least one episode of food sticking in oesophagus. Absolute figures not provided **Child growth** 93% of patients were above the 10th weight percentile	**Mortality** 11% (8/70) of patients had died before 2 years of follow up, cause of death not related to the anastomosis procedure.	Outcomes are not reported separately for cases of long-gap atresia, or those who had traction of the oesophageal ends and delayed repair. Inconsistency between report text and table in number of cases followed up for telephone interview. No details given of case selection criteria or process. Baseline characteristics not well reported. 7% (5/70) of patients lost to follow-up, no comparison made. Majority of outcomes are subjective assessment and self reported.

Abbreviations used: OA – oesophageal atresia,			
Study details	**Key efficacy findings**	**Key safety findings**	**Comments**
Al-Qahtani A R (2003)(2) Case reports Canada n = 3 Age = delivered after 31 to 37 weeks of gestation, male = 100%, weight = 1.38 to 2.3 kg, oesophageal atresia = 3 to 5 cm, traction of oesophageal ends = 8 to 13 days Foker technique with placement of traction sutures to both oesophageal pouches brought through the thoracic wall under slight tension. Ends pulled 1 to 2 mm daily, once the ends were in proximity anastomosis was performed Follow-up = 4 months to 1 year	**Clinical outcomes** 67% (2/3) of the cases achieved full oral feeding at 28 days and 4 months, 33% (1/3) had mild but improving swallowing difficulty at 4 months All cases (3/3) demonstrated good weight gain at final follow-up **Anastomosis success** Contrast oesophagrams showed a leak in 67% (2/3) cases, this responded to conservative treatment in one case and was controlled with drainage in another	**Intervention complications** 67% (2/3) cases reported loosening or withdrawal of sutures to oesophageal ends during period of traction **Complications** Gastroesophageal reflux 67% (2/3) Stenosis requiring dilatation 33% (1/3)	Qualitative measures used for main outcomes. Methos of case selection for this procedure not stated. Experience of operator not stated. Relatively short follow-up. Authors state that the first stage of the operation (to establish traction) may be achieved through a thorascopic approach in future.

Abbreviations used: OA – oesophageal atresia,			
Study details	**Key efficacy findings**	**Key safety findings**	**Comments**
Skarsgard E D (2004)(3) Case reports Canada n = 2 Age = 3 to 5 months, male = 50%, oesophageal atresia = 5 to 5.5 cm, traction of oesophageal ends = 10 to 14 days Modified Foker technique with placement of traction sutures to both oesophageal pouches brought through the back. Ends pulled 1 mm daily or every other day, once the ends are in proximity anastomosis was performed Follow-up = 14 months	**Clinical outcomes** One case (50%) was being fed by mouth and gastrostomy tube, and one case eating solids normally at 1 year follow-up **Anastomosis success** Intact anastomosis confirmed in both cases (2/2) by contrast oesophagrams	**Complications** Gastroesophageal reflux 50% (1/2) Anastomotic stricture despite pneumatic dilatation, and fundoplication 50% (1/2). This case required a stricture resection at 14 months	Method of case selection is not defined. No quantitative outcome assessment of efficacy. No suture failure with this modified technique of providing traction to oesophageal ends. Infants supported on gastrostomy tube for a few months before procedure initiated to allow for some natural growth of oesophageal ends. Authors comment that there is a lack of standardisation of the long-gap terminology.
Gaglione G (2002)(4) Case reports Italy n=2 Age =delivered after 38 weeks of gestation to 3 months, Male =0%, Oesophageal atresia = 3cm to 6.5 vertebral lengths, traction of oesophageal ends =8to 10 days Traction sutures to both oesophageal pouches, external traction to top section only, internal traction to distal pouch by suture to the prevertebral fascia Follow up = to one month.	**Anastomosis success** Intact anastomosis confirmed in 50% (1/2) cases, one case showed a small leak that settled with conservative management	**Complications** Gastroesophageal reflux 50% (1/2), treated with Nissen fundoplication at 1 month Anastomotic stricture 100% (2/2). This case required a stricture resection at 14 months	No clinical outcomes reported, only technical success. Case selection not described. Assessment measure of atresia distance not described. Incidence of concomitant fistula not standardised. Experience of operator not described. Length of follow-up not clearly defined.

Abbreviations used: OA – oesophageal atresia,			
Study details	**Key efficacy findings**	**Key safety findings**	**Comments**
Lopes M F (2004)(5) Case report (1 case) Portugal Age = 3 months, male = 100%, weight = 4.7kg, oesophageal atresia = 5.5 vertebral bodies, traction of oesophageal ends = 13 days Traction sutures to proximal and distal oesophageal pouches, and delayed primary anastomosis under significant tension. Follow up = 9 months	**Clinical outcomes** At 9 months following the procedure the patient had satisfactory weight gain and was eating a normal diet **Anastomosis success** Intact anastomosis without leaks was confirmed at 10 days follow up by contrast oesophogram Sutures to the distal oesophagus broke free during traction	**Complications** The patient suffered gastroesophageal reflux and was treated with Nissen fundoplication at 3 weeks Prophylactic oesophageal dilations were performed at 6 and 12 weeks	No quantitative evaluation of clinical outcomes. Experience of operator not described. Procedure delayed for 3 months with gastrostomy feeding.

Validity and generalisability of the studies

- Variation in timing of treatment between studies: at birth or delayed for a few months.
- Very small case series and reports, which limits the generalisability of findings.
- Highly selected patient cohorts in the reported series.
- Significant variability in the methods used for oesophageal traction.
- Some cases with isolated atresia and others with tracheo-oesophageal fistula(s).

Specialist Advisors' opinions

Specialist advice was sought from consultants who have been nominated or ratified by their Specialist Society or Royal College:

Mr Buick, Mr MacKinlay, Professor Spitz

- Advisors considered this a novel procedure of uncertain safety and efficacy.
- Primary anastomosis using the patients own oesophagus is a desirable objective, and the aim of therapy is to enable weight gain.
- The procedure may require a shorter length of stay than alternatives.
- Observed adverse events include stricture formation and gastro-oesophageal reflux.
- Additional theoretical adverse events that may accompany the procedure include leaks at the anastomosis, suture disruption during period of traction, gasto-oesophageal atresia, gastric emptying disorder and difficulties in swallowing.
- The rare incidence of long-gap atresia limits the opportunity to train in the technique
- The rare incidence of long-gap atresia means that the impact on the NHS of introducing this technique is likely to be minor.
- Audit of all cases, with careful evaluation of the length of atresia, would be useful in order to delineate where the Foker technique should be used as opposed to conventional anastomosis.
- It is likely to be used in minority of UK hospitals, in specialist centres.
- Advisors note that the technique has not been adopted in specialist paediatric centres in the USA.

Issues for consideration by IPAC

- Long-gap oesophageal atresia is rare among cases of atresia.
- Efficacy and safety of alternative interventions need to be borne in mind when considering the technique.

References

(1) Foker JE, Linden BC, Boyle EM, Jr., Marquardt C. Development of a true primary repair for the full spectrum of esophageal atresia. Ann Surg 1997; 226(4):533-541.

(2) Al Qahtani AR, Yazbeck S, Rosen NG, Youssef S, Mayer SK. Lengthening technique for long gap esophageal atresia and early anastomosis. Journal of Pediatric Surgery 2003; 38(5):737-739.

(3) Skarsgard ED. Dynamic esophageal lengthening for long gap esophageal atresia: Experience with two cases. Journal of Pediatric Surgery 2004; 39(11):1712-1714.

(4) Gaglione G, Tramontano A, Capobianco A, Mazzei S. Foker's technique in oesophageal atresia with double fistula: a case report. Eur J Pediatr Surg 2003; 13(1):50-53.

(5) Lopes MF, Reis A, Coutinho S, Pires A. Very long gap esophageal atresia successfully treated by esophageal lengthening using external traction sutures. Journal of Pediatric Surgery 2004; 39(8):1286-1287.

(6) Foker JE, Kendall TC, Catton K, Khan KM. A flexible approach to achieve a true primary repair for all infants with esophageal atresia. Seminars in Pediatric Surgery 2005; 14(1):8-15.

Appendix A: Literature search for Foker technique for long-gap oesophageal atresia

The following search strategy was used to identify papers in Medline. A similar strategy was used to identify papers in EMBASE, Current Contents, PreMedline and all EMB databases.

For all other databases a simple search strategy using the key words in the title was employed.

Procedure Number: **255**	**Procedure Name:** **Foker technique for oesophageal atresia**
Database: Medline	**Date searched: 1/12/04**

---

1 ((oesophag$ or esophag$) adj3 atresia).tw. (1854)
2 ((oesophag$ or esophag$) adj3 gap$).tw. (160)
3 ((oesophag$ or esophag$) adj3 defect$).tw. (371)
4 (atretic adj2 (esophag$ or oesophag$)).tw. (9)
5 digestive tract defect$.tw. (3)
6 (aplasia adj3 (esophag$ or oesophag$)).tw. (7)
7 exp Esophageal Atresia/ (1988)
8 or/1-7 (2758)
9 foker$.tw. (3)
10 Foker JE.au. (75)
11 Foker J.au. (15)
12 foker$.af. (96)
13 external traction.tw. (26)
14 (traction$ adj2 sutures).tw. (75)
15 ((oesophag$ adj3 traction) or (esophag$ adj3 traction)).tw. (39)
16 primary anastomosis.tw. (808)
17 ((esophag$ or oesophag$) adj2 (grow$ or induc$)).tw. (1299)
18 or/9-17 (2327)
19 8 and 18 (113)
20 limit 19 to human (94)
21 from 20 keep 1-94 (94)
22 Intraoperative Complications/ (16300)
23 Postoperative Complications/ (201391)
24 exp SAFETY/ (23907)
25 exp Risk Factors/ (253507)
26 safe$.tw. (202322)
27 side effect$.tw. (99404)
28 undesirable effect$.tw. (1106)
29 treatment emergent.tw. (414)
30 tolerability.tw. (11852)
31 adverse effect$.tw. (45705)
32 adverse reaction$.tw. (13899)
33 adverse event$.tw. (20018)
34 adverse outcome$.tw. (3907)
35 or/22-34 (784414)
36 20 and 35 (42)
37 from 36 keep 1-42 (42)