Thoracoscopic Elongation of the Esophagus in Long-Gap Esophageal Atresia

25

David C. van der Zee

Introduction

Esophageal atresia has always been the hallmark of pediatric surgery. Long-gap esophageal atresia (LGEA) has been a challenge for many pediatric surgeons for many decades. Several alternative techniques have past the revenue, some to stay, and some to go. As early as in the late 1950s of the past century, Rehbein [1] already described the approximation of both ends with two metal balls in the esophagus attached to a thread in between the two ends that were slowly pushed to one another.

The fact that many different procedures have been developed over the years since indicates that the procedures do not have a guaranteed adequate success rates, and in many instances, it was wise to postpone treatment until the child was somewhat older. Meanwhile the child was either given a spit fistula or there should be continuous suction from the proximal esophagus to prevent aspiration, requiring intensive nursing care.

Two main principles are at hand when to decide which technique will be used. A popular technique that has been used over the years is the replacement of the esophagus with either the stomach, jejunum, or colon [2–4]. Others advocate that the original esophagus is always the best and pursue techniques that will result in elongation of the esophagus [5]. Whatever technique is used, there will always be two ends put together that were not tuned to each other, and motility disorders will occur in either technique.

In 1997, John Foker et al. [5] published an article in which they described a technique in which they approximated the two ends of the esophagus with traction sutures that were brought outside, and with traction, the two ends could be approximated and a delayed primary anastomosis could be made. They hypothesized that traction and growth were responsible for the elongation. Some other publications followed with similar good results.

With the advent of minimal invasive surgery, it was just a matter of time before the first publications came with results from thoracoscopic repair of esophageal atresia. In 2005 Holcomb et al. [6] published the results from a multicenter study where 103 children had undergone thoracoscopic repair of their esophageal atresia. In 2007, van der Zee and Bax [7] published a single center study on 51 neonates with thoracoscopic repair of type C esophageal atresia.

With increasing experience in the thoracoscopic repair of esophageal atresia, it was a logical step to attempt a thoracoscopic approach to the repair of LGEA.

D.C. van der Zee, MD, PhD
Department Pediatric Surgery KE.04.140.5,
University Medical Center, Wilhelmina Children's Hospital, P.O.Box 85090, Utrecht 3508 AB,
The Netherlands
e-mail: d.c.vanderzee@umcutrecht.nl

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In 2007, van der Zee et al. [8] published the technique of thoracoscopic elongation of the esophagus in LGEA.

In this chapter, the technique will be described and the results will be discussed of thoracoscopic repair of LGEA.

Technique

After the general work-up for VACTERL association, the principal first step in LGEA is to make a (laparoscopic) gastrostomy for feeding and to perform a contrast study to determine the length of the distal esophagus. Principally one could keep the child on parenteral nutrition during the process of the elongation procedure, but enteral feeding is preferred and has the benefit of gastroenteral stimulation.

With the aid of the Replogle tube in the proximal esophagus, the length of the proximal esophagus can be determined.

There is no strict age or weight limit.

For the procedure, the child is put in left semiprone position, with a support under the left arm pit to avoid compression of the vasculature. The right arm is extended over the head.

In some centers, the procedure is preceded by a bronchoscopy to determine or exclude a proximal fistula.

A 5 mm trocar is placed approximately 1 cm. below and anterior of the scapula point for the optic device. Two 3 mm trocars are placed in a triangle around the first trocar, as far apart as possible to avoid entangling.

CO2 insufflation is started with 5 mmHg pressure and a flow of 2 lt/m. It is waited for the anesthesiologist to settle the ventilation satisfactory. Usually this means that the frequency needs to be turned up.

By pushing gently with two 3 mm. graspers on the lung desufflation of the lung is accomplished. When and only when adequate view is obtained, the proximal and distal esophagus can be identified. When insufficient desufflation is obtained, a fourth 3 mm. trocar can be introduced with a flexible retractor to carefully press down the lung as far is necessary for adequate view.

It is started with the mobilization of the proximal esophagus up to the thoracic aperture (Fig. 25.1). It is important to determine that there is no proximal fistula; otherwise, this should be dealt with. In general, it is possible to close the proximal fistula thoracoscopically, but when the fistula is too high up in the neck, this should be done from the neck.

Then the distal esophagus can be mobilized under control of the vagal nerve, if necessary down into the hiatus (Fig. 25.2).

As the esophagus naturally lies in the posterior mediastinum, the traction sutures should be brought out as much posteriorly as possible to maintain its course, as well as the sutures not interfering too much with the lung after insufflations of the lung at the end of the procedure.

An Endoclose® device is used to introduce Vicryl® 4×0 sutures together with the needle (Fig. 25.3). For this purpose, a tiny skin incision is made at a level, either maximal cranial next to the scapula or caudal next to the spine. In total four sutures are laid at four corners of both the proximal and distal esophagus and pulled out again with the same Endoclose® (Figs. 25.4 and 25.5). A small silicone tube is used to bring the four sutures together and above this tubing traction is carried out with a mini-mosquito clamp. At the top of both the proximal and distal esophagus, a metal clip is attached to the sutures to allow for radiological determination of the progress of the elongation over the coming days.

After finishing the first procedure, the trocars are removed and the defects are closed with Vicryl® 5×0 sutures and Steri-strips® (Fig. 25.6).

Postoperatively, the child is extubated and only remained on light sedatives. Feeding is started the next day via the gastrostomy. Twice daily the sutures are checked for patency and traction is reinstalled on the sutures. Once daily a plain X-ray of the thorax is performed to determine the position of the clips.

When the clips have approximated sufficiently, a second procedure is executed. The patient is put in a similar position and the trocars are reinstalled. The amount of adhesions usually is limited and can be released without great difficulty. By releasing the tension from

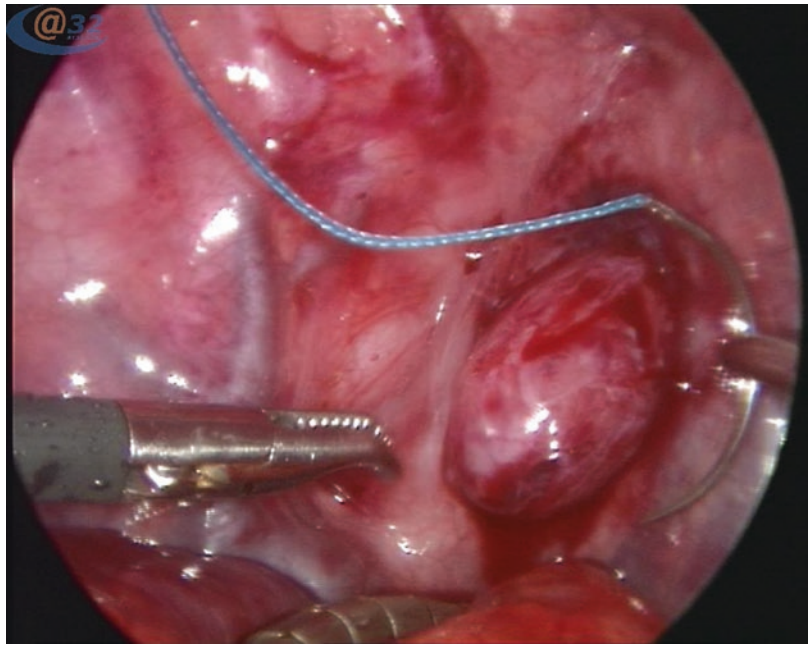

Fig. 25.1 Mobilization of proximal esophagus

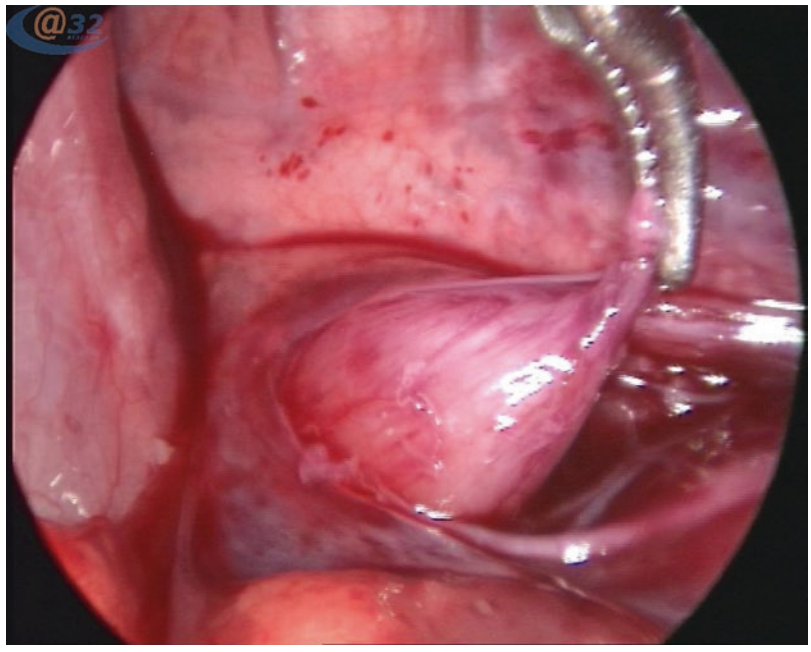

Fig. 25.2 Mobilization of distal esophagus

the outside sutures, it can be determined whether the esophageal ends can be approximated sufficiently at the level of the posterior mediastinum (Fig. 25.7).

The traction sutures are cut and taken down. Vicryl®5×0 sutures are used for the anastomosis. The esophageal ends are cut open with scissors, and the first one, two, or even three sutures are

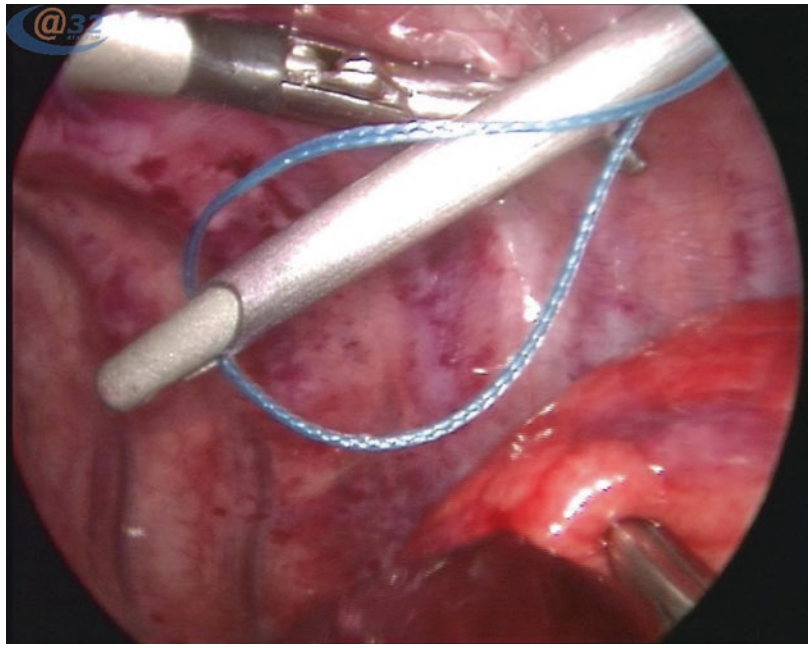

Fig. 25.3 The use of an Endoclose® to introduce a Vicryl® 4×0 suture and needle

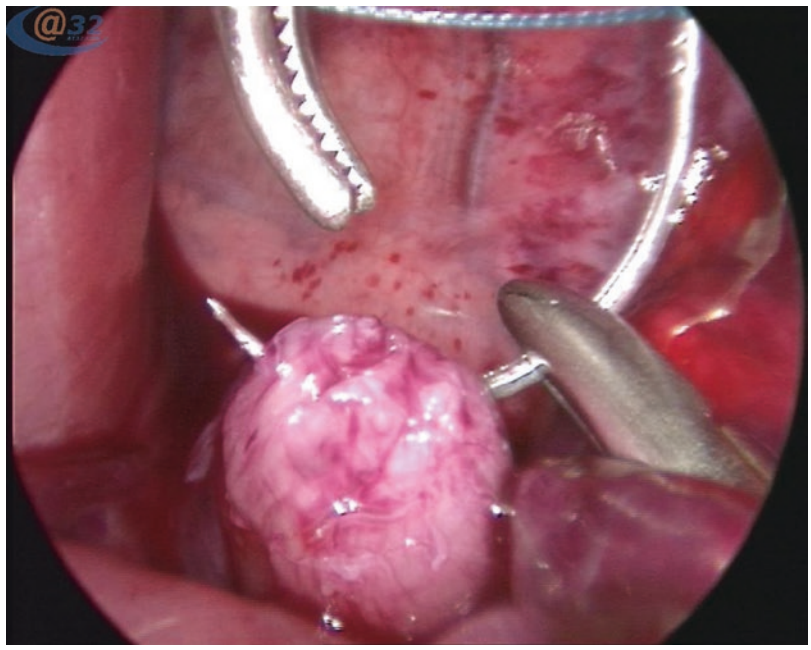

Fig. 25.4 Placing of first suture in distal esophagus

laid with a sliding knot to slowly approximate the proximal and distal esophagus. Thereafter, additional sutures are laid to complete first the posterior wall and introduce a 6F silicone nasogastric tube and then finish the anterior anastomosis (Fig. 25.8).

The trocars are removed and the defects are closed using Vicryl®4×0.

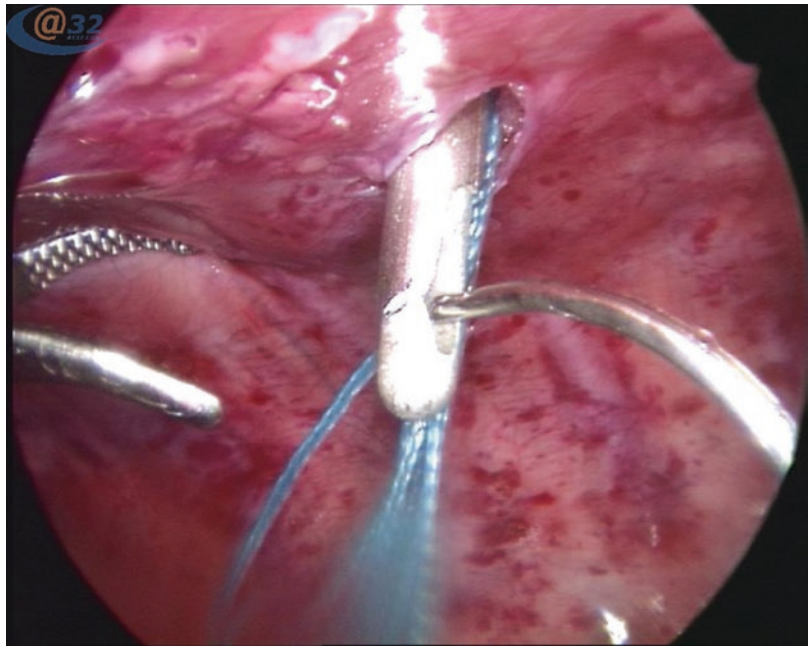

Fig. 25.5 Retrieval of suture and needle with the use of an Endoclose®

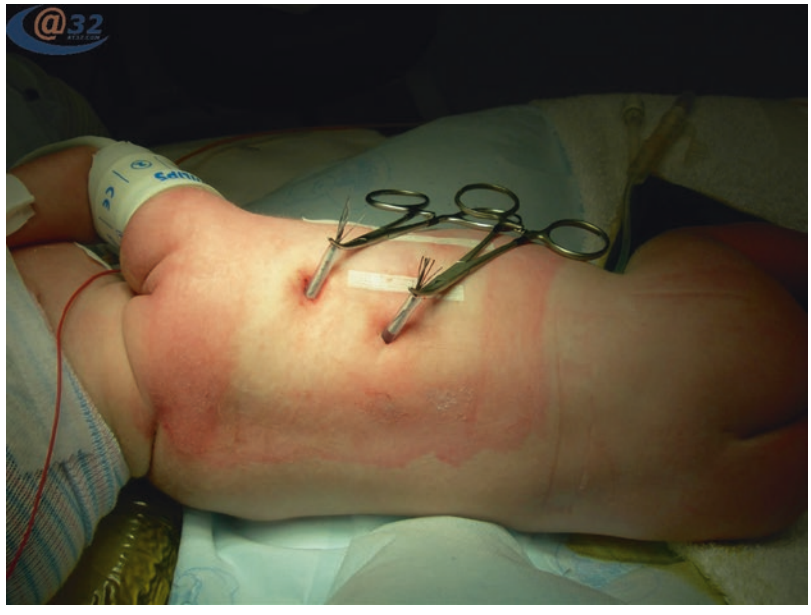

Fig. 25.6 Sutures are placed under traction over a Silicone tube

The child is extubated and kept on mild sedatives for the first 2–3 days. Antacids and prokinetics are started.

Gastric tube feeding is usually started after 2 days, although gastroesophageal reflux is frequently occurring, necessitating the gastrostomy feeding tube to be advanced into the duodenum.

After 5 days, an esophageal contrast study is performed to determine the patency of the esoph-

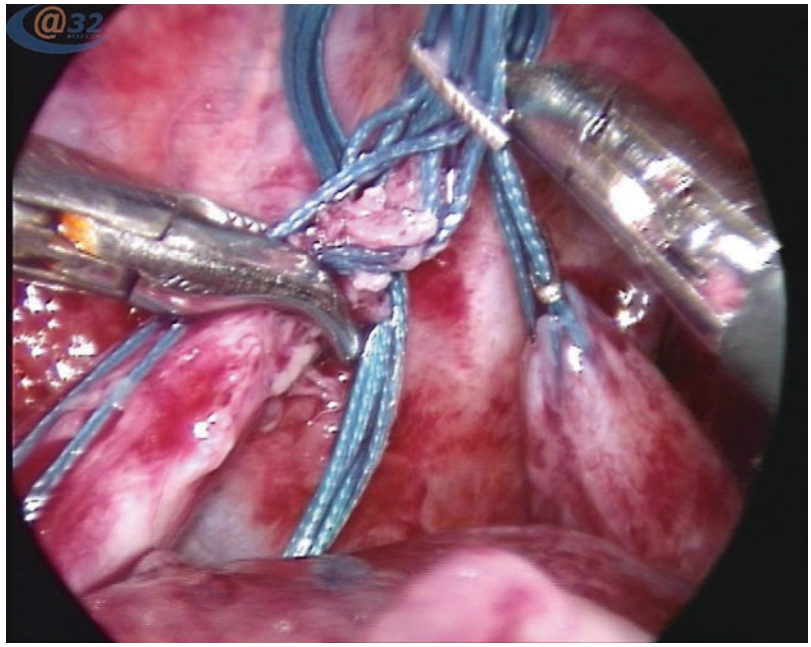

Fig. 25.7 Both ends of the esophagus have approached each other sufficiently to perform a delayed primary anastomosis

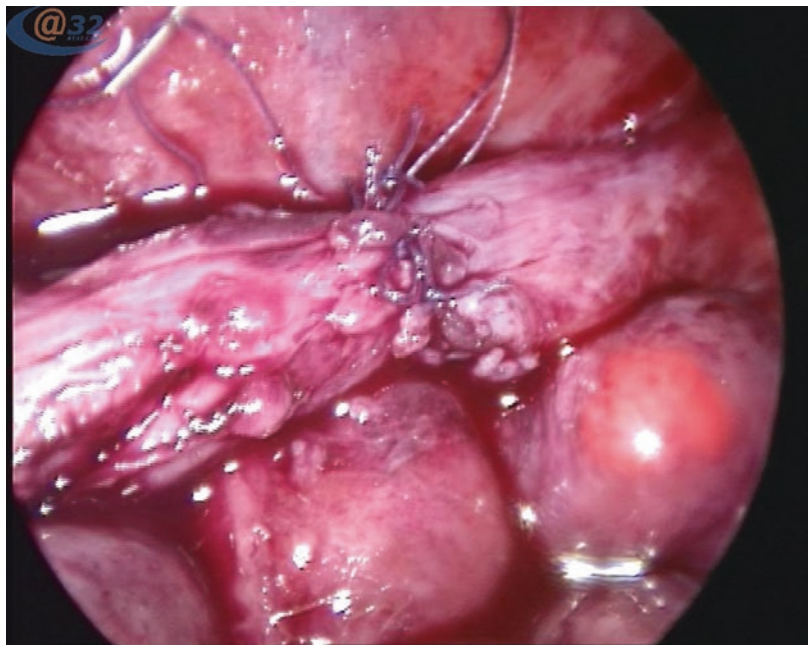

Fig. 25.8 Result after delayed primary anastomosis of proximal and distal esophagus

agus. When there is no leakage, oral feeding can be progressively started.

When the child is on full oral feeding, it can be discharged from the hospital.

The child is seen at the outpatient department every second week for the first 6 weeks. Thereafter, the follow-up is extended up to 1, 3, 6, and 12 months.

Complications

Preoperative

When a proximal fistula is present, the child can suffer from pulmonary complications. Many institutions advocate early trachea-bronchoscopy to exclude a proximal fistula.

The child can also present with complications from comorbidity, such as cardiovascular disease.

Intraoperative

Rupture of the traction sutures may occur. If this happens, the child needs to be taken back to the operating room to replace the traction sutures. However, when due to this complication one of the esophageal ends has ruptured, it is advised to abandon this technique and go back to one of the other alternative techniques, like gastric pull-up or jejunal interposition.

Postoperative

When an anastomosis is made under tension, the risk for anastomotic leakage is present. When leakage occurs, it usually suffices to place an intrathoracic drain, preferably through one of the trocar holes. Over a few days, the leakage stops spontaneously, and the drain can be withdrawn afterward.

In case a small residual diverticulum persists, this can usually be treated conservatively, as long as there are no sequelae from the diverticulum. Otherwise the diverticulum can be resected thoracoscopically at a later stage.

Usually esophageal stenosis occurs, in spite of the antireflux medication, necessitating esophageal dilatation, the first 2–3 weeks postoperatively. When recurrence of esophageal stenosis persists, a laparoscopic antireflux procedure can be planned between 4 and 6 weeks postoperatively.

Own Results

Between 2007 and 2009, there were four children with a long-gap esophageal atresia that were presented to our department.

The first child was born prematurely at 32 weeks of gestation with a birth weight of 1,500 g. She soon after birth showed signs of aspiration, due to a proximal fistula.

We initially deemed the child too small for a first case of thoracoscopic elongation; thus, we performed a thoracoscopic closure of the proximal fistula as a first step.

Four weeks later at 36 weeks of gestation and 2,000 g, she underwent the thoracoscopic elongation. She endured the procedure without any problem.

During postoperative follow-up over the next days, the clips approached each other progressively; until on the fourth day, the distal traction sutures came out, after a change of position in the crib. She was taken into theater and new traction sutures were placed.

After another 2 days, the esophageal ends had approximated sufficiently to perform a delayed primary anastomosis without complications.

At the contrast study on day 5, there was some minor extravasation of contrast at the site of the anastomosis. The feeding over the gastrostomy was continued for another 3 days after which oral feeding was started without complications.

Ten days after surgery, she was discharged from the hospital.

At follow-up after 2 weeks, she had developed an esophageal stenosis, which was dilated up to

F8. After 2 weeks at planned endoscopy, she showed a renewed stenosis that was dilated up to F10. After dilatation, the stenosis could be passed with the endoscope and a large hiatal hernia was seen.

She was therefore planned for a laparoscopic antireflux procedure 1 week later, at which occasion the esophagus was dilated again up to F10.

Thereafter, she required no more dilations and now is 3 years old and eating all that is offered without any restrictions. She has a normal development and length and weight are according to her age.

The second child was a term born boy with a weight of 3,500 g. There were no other anomalies. He underwent the first step of the procedure at the age of 3 days without any complication. After 3 days, the sutures form the distal esophagus came out and he was taken back into surgery. At renewed thoracoscopy, there were few adhesions, but the distal esophagus had been torn open. Closure of the rupture would increase the distance again and new sutures would have to be placed at the site of the rupture. Also because it was the distal esophagus, there was an increased risk of infection. It was therefore decided to close the rupture in the distal esophagus and abandon the thoracoscopic elongation procedure.

He was put on antibiotics for 5 days and underwent a jejunal interposition 2 weeks later.

The boy is now 2½ years old, has a normal development, and is eating everything with the family without restriction.

A third child came to us from abroad at the age of 5 months with a weight of only 3,800 g. She had a gastrostomy for feeding and a suction tube in the proximal esophagus.

After inventarization, she underwent the first step thoracoscopy without any complication. Because of her malnutrition, she was fed intravenously and kept on the ventilator postoperatively while mildly sedated.

After 5 days, the esophageal ends had approximated sufficiently for thoracoscopic delayed primary anastomosis. She underwent the procedure without complications, although the anastomosis had been made under considerable tension.

On the fifth postoperative day, she developed leakage with pleural effusion for which a thoracic tube was placed. On starting gastrostomy feeding, the milk came out of the drain. The feeding tube was therefore advanced into the duodenum and feeding was accepted.

The drain was productive for 5 days after which it could slowly be withdrawn and removed after 10 days. On contrast study, there remained a small sinus at the site of the anastomosis, which gave no clinical symptoms. After 15 days, the mother could give her daughter the first bottle feeding in 6 months (Fig. 25.9).

After 4 weeks, she underwent a laparoscopic antireflux procedure for recurrent stenosis. The small sinus remained unchanged.

After they returned to their home country, she has had some more dilations to maximize the diameter, in order not to increase the pressure on the diverticulum and with that have the risk of increasing the size.

She is now 1½ years after the procedure and eating well. Her length and weight have improved considerably after the operation.

The fourth child also came from abroad and had undergone multiple prior attempts on open Foker procedure elsewhere without success. As he came to us, he was 2 years old, weighing 12 kg.

He had a spit fistula after several attempts of Kimura elongation of the proximal esophagus.

After mobilizing the proximal end, the esophagus merely just reached up to the thoracic aperture.

When opening up the thorax, it became apparent that the whole esophagus had changed into solid scar tissue without any patency. It was decided to make a jejunal interposition, of which the proximal anastomosis could just be made inside the thoracic aperture.

The postoperative course was without complications and he could be discharged after 2×s. He is now over 1 year after the jejunal interposition and eating a normal diet with the rest of the family (Fig. 25.10).

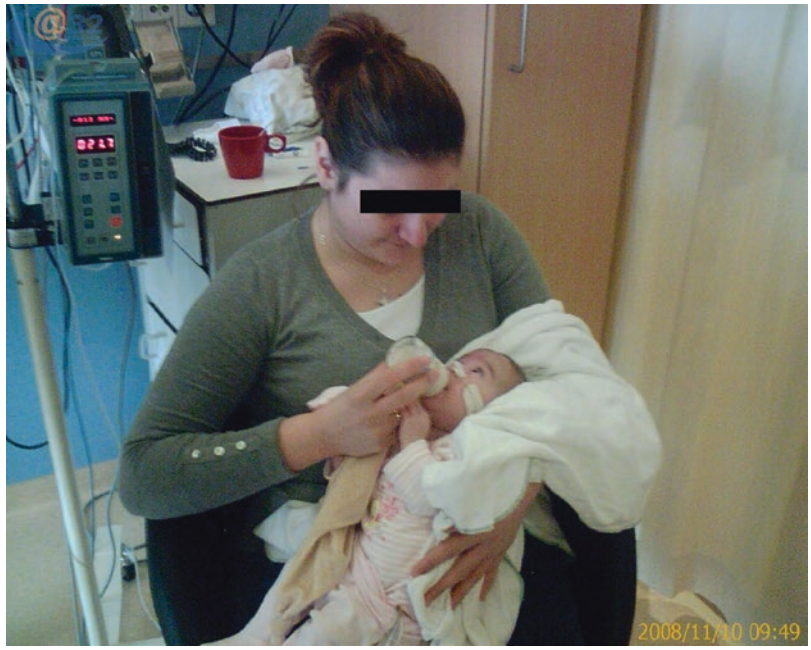

Fig. 25.9 Third patient receiving first bottle feeding after delayed primary anastomosis at the age of 5 months

Fig. 25.10 Patients three and four 2 and 1½ years after operation, respectively, during encounter at airport abroad

Discussion

Long-gap esophageal atresia, i.e., without a distal fistula, has always been a challenge for pediatric surgeons. In a recent survey by Ron et al. [9] in the UK, the majority of pediatric surgeons would either choose for a gastric pull-up or perform the Foker technique for long-gap esophageal atresia.

With regard to the thoracoscopic approach of esophageal atresia with trachea-esophageal fistula, about half of the pediatric surgeon had experience in endoscopic surgery, but only a small percentage

had experience with thoracoscopic repair of esophageal atresia. On the other hand, about three-quarters of them is considering on starting on thoracoscopic repair of esophageal atresia.

The thoracoscopic repair of long-gap esophageal atresia, however, is of another dimension.

It requires expert skills in endoscopic dissection and suturing, often under considerable tension. In case complications occur, a broad armamentarium of alternative techniques should be available to deal with the problems and bring the procedure to a good end.

It is known from aviation that airplane crashed always are a resultant of multiple mistakes and/or misjudgments. The (thoracoscopic) Foker technique can give excellent results, if all goes well. However, if complications do occur, there should be a low threshold to change to alternative techniques. Therefore, the thoracoscopic Foker technique should be foreclosed to a limited number of centers of expertise.

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