Thoracoscopic repair of esophageal atresia with a distal fistula – lessons from the first 10 operations

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Abstract

Introduction: *Thoracoscopic esophageal atresia (EA) repair was first performed in 1999, but still the technique is treated as one of the most complex pediatric surgical procedures.*
Aim: *The study presents a single-center experience and learning curve of thoracoscopic repair of esophageal atresia and tracheo-esophageal (distal) fistula.*
Material and methods: *From 2012 to 2014, 10 consecutive patients with esophageal atresia and tracheo-esophageal fistula were treated thoracoscopically in our center. There were 8 girls and 2 boys. Mean gestational age was 36.5 weeks and mean weight was 2230 g. Four children had associated anomalies. The surgery was performed after stabilization of the patient between the first and fourth day after birth. Five patients required intubation before surgery for respiratory distress. Bronchoscopy was not performed before the operation.*
Results: *In 8 patients, the endoscopic approach was successfully used thoracoscopically, while in 2 patients conversion to an open thoracotomy was necessary. In all patients except 1, the anastomosis was patent, with no evidence of leak. One patient demonstrated a leak, which did not resolve spontaneously, necessitating surgical repair. In long-term follow-up, 1 patient required esophageal dilatation of the anastomosis. All patients are on full oral feeding.*
Conclusions: *The endoscopic approach is the method of choice for the treatment of esophageal atresia in our center because of excellent visualization and precise atraumatic preparation even in neonates below a weight of 2000 g.*

Key words: *videothoracoscopy, esophageal atresia, distal esophageal fistula.*

Introduction

The thoracoscopic approach in esophageal atresia (EA) is one of the most important achievements in pediatric surgery. In 1999, Steve Rothenberg performed the first thoracoscopic repair of an esophageal atresia in a 2-month-old infant. In the next year, the first thoracoscopic approach in esophageal atresia with a distal trachea-esophageal fistula was achieved [1, 2]. In spite of the small capacity of the pleural cavity in neonates, visualization is excellent, and the minimally invasive endoscopic approach is even more comfortable than open thoracotomy. Of course, this is influenced by the experience of the surgeon and good cooperation with the anesthesiologist during surgery. Although clinical reports are increasing, clinical information in the literature is rare. We present our experience in the thoracoscopic repair of congenital esophageal atresia in 10 consecutive patients treated in our center.

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Aim

This study presents a single-center experience and learning curve of thoracoscopic repair of esophageal atresia and tracheo-esophageal (distal) fistula.

Material and methods

Between November 2012 and March 2014, 10 consecutive neonates born with EA and distal tracheo-esophageal fistula were admitted to our hospital. There were 8 girls and 2 boys. Gestational age varied from 34 to 39 weeks (mean: 36.5 weeks). Birth weight ranged between 1820 g and 2820 g (mean: 2230 g). The surgery was performed after stabilization of the patient between the first and fourth day after birth. In all patients, echocardiography was performed before surgery. In 3 patients, congenital heart disease was diagnosed (a ventricular septal defect in 2 patients, and an atrial septal defect in 1 patient) but this was not a contraindication to the minimally invasive approach. In all patients, the aortic arch was typically located on the left side. In 1 patient, hypospadias was recognized. Five patients required intubation before surgery for respiratory distress. Bronchoscopy was not performed before the operation.

Surgical technique

The patient was in an almost prone position with a slight elevation of the right side of the thorax. The first 3 mm camera port was inserted below the tip of the scapula. The second 3 mm port was located paravertebrally, and the camera was changed to this port. Under direct visualization, the third 5 mm port was inserted in the anterior auxiliary line. The 5 mm port was chosen because 5 mm titanium clips were used to close the fistula. At the beginning of the operation, the distal esophagus was mobilized without dissection of the azygos vein and clipped with two titanium clips (Endoclip3, Covidien) close to the trachea. At this step of the operation, the distal esophagus was not transected. The esophageal tube inserted by the anesthesiologist helped in the localization of the upper esophagus. The upper pouch was dissected proximally. A firm connection between the upper pouch and the trachea, which might result in accidental opening of the esophagus, was usually observed. The proximal esophagus was elongated by blunt dissection. Once adequate mobilization was obtained, the tip was cut off. The distal esophagus was transected from the trachea, and an anastomosis was performed. Usually, 3 stitches (Novosyn 5-0, Braun) were knotted on the rear wall of the esophagus with the knots made on the outside, then the gastric tube was advanced through the distal esophagus and located in the stomach. After that, the anterior wall of the anastomosis was completed (Photo 1). In the first 3 cases only, thoracic tubes were left in the pleural space with the tip of the tube located near the anastomosis, but subsequently the pleural cavity was closed without drainage.

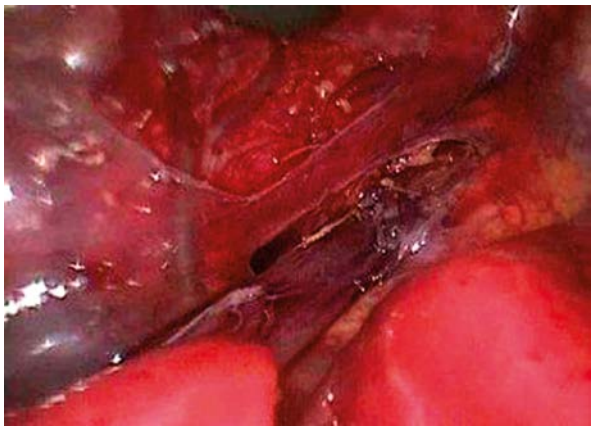

Photo 1. Completed anastomosis with interrupted sutures with the knots made on the outside

Results

Eight of 10 procedures were completed successfully thoracoscopically. In 2 patients, the surgery was converted to an open procedure due to severe respiratory distress connected with lung collapse because of the deep insertion of the endotracheal tube. The conversions were performed after preparation of both parts of the esophagus, which resulted in very easy and quick completion of the anastomosis in open mode. In all patients except 2, the anastomosis was completed without significant tension on it. In 1 patient during elongation of the upper pouch the trachea was opened. The trachea was closed without complications. The contrast study was performed routinely on the tenth day after the operation. In 9 patients, there was no evidence of leak, but in 1 patient persistent leakage which did not resolve spontaneously required reoperation.

The fistula was closed with 1 stitch, and the later course was uncomplicated. The mean duration of the operation from skin to skin was 140 min, with a range of 110–225 min. The duration of the first operation was 225 min. Subsequently, the duration was stable at about 120 min, so we did not observe a remarkable influence of the learning curve on the operating time in the following operations. The time of observation was from 8 to 31 months (mean: 18.2 months). Between 6 and 12 months in all patients, an X-ray contrast study of anastomosis patency was performed. One patient required esophageal dilation due to stricture recognized in the X-ray contrast study (Photos 2, 3). All patients are now on full oral feeding.

Discussion

The overall survival rate of neonates with esophageal atresia is presently more than 90%; mortality is connected with prematurity, underlying cardiac anomalies and chromosomal defects [3]. The excellent results in this group of patients are related to improvements in intensive care support but also in the development of surgical techniques and surgical equipment. This natural progress in treatment was achieved by using the endoscopic approach as an alternative to open repair. Minimally invasive operations in neonates are still very demanding, even in experienced hands. The crucial point is excellent cooperation between the surgeon and the anesthesiologist due to the risk of very serious intraoperative complications connected with compression of the lung. In our series, in 2 patients, problems with blood saturation during lung collapse were indications for conversion. Intracorporeal suturing when urgent lung expansion is required might be very dangerous and might result in lung damage, so we decided to convert to an open procedure. The postoperative analysis revealed that the endotracheal tube was inserted too deep into the right bronchus and the positive intrapleural pressure was not tolerated. In the subsequent procedures, a meticulous assessment of endotracheal tube position before surgery was performed to avoid problems with saturation during right lung collapse.

In our series, we observed postoperative anastomotic strictures only in 1 case, recognized by the contrast study (10%). In other reported series, anastomotic strictures ranged from 8% to 45% [1, 2, 4, 5].

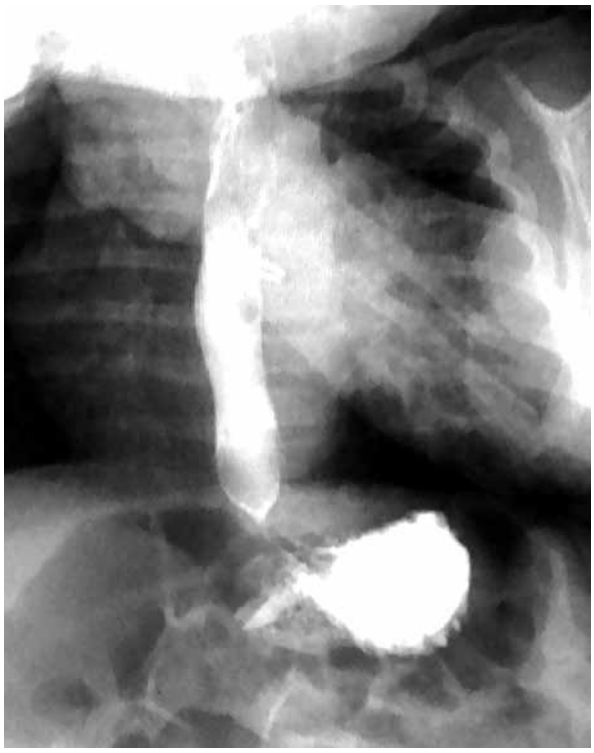

Photo 2. Control X-ray study – the site of the anastomosis very wide

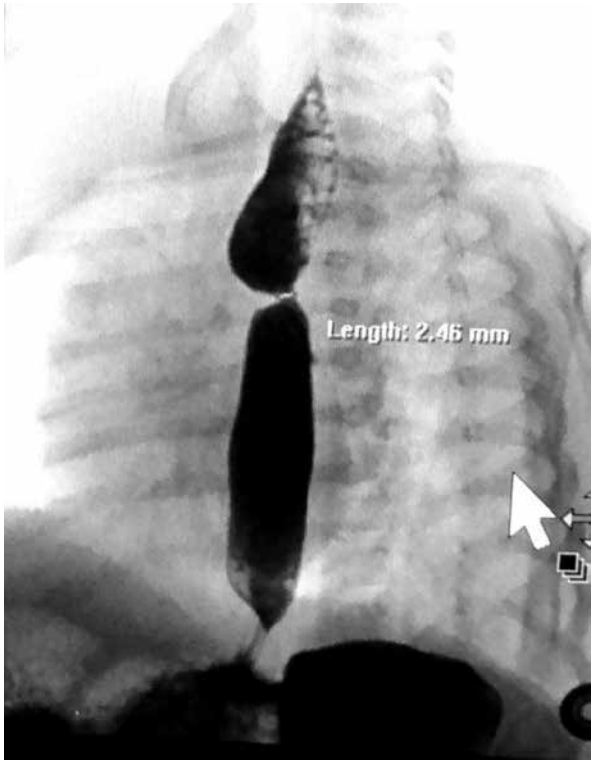

Photo 3. Control X-ray study. Stenosis of anastomosis required dilatation

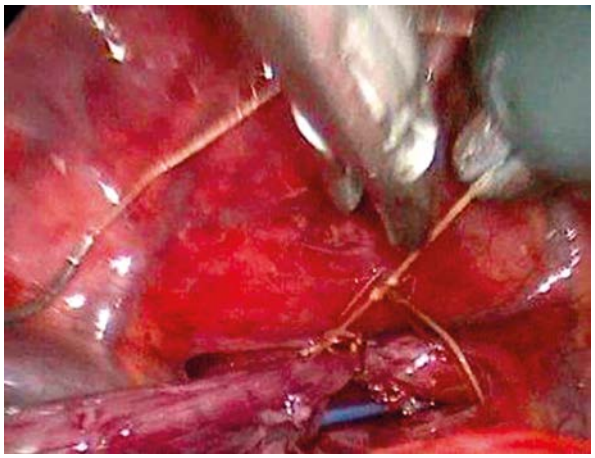

Photo 4. A technique of knotting which allowed for atraumatic tightening of the anastomosis

In our technique, we cut off the end of the upper pouch, so its opening was very wide. Van der Zee *et al.* analyzed 72 patients operated on between 2000 and 2010 and divided them into 2 groups to compare early and late experiences. The incidence of anastomotic stenosis diminished from 38% to 19% and was connected with changing the incision technique of the upper pouch. The authors also preferred continuous suturing [5]. We prefer single sutures with knots on the outside of the anastomosis, and we also try to use maximally 7 stitches (range: 5–8). The anastomosis was performed with a braided and coated synthetic mid-term absorbable suture (Novosyn 5-0, Braun). Rothenberg prefers monofilament absorbable sutures, but in our opinion it is more difficult to bind it during intra-corporeal suturing [6]. The first stitch was knotted with a technique which allowed for atraumatic tightening of the anastomosis (Photo 4). The first stitch usually has to be longer, because the ends of the esophagus are a long distance one from another. The most important element of performing the anastomosis is meticulous adaptation of the layers of the esophagus, especially the mucosa. In our opinion, this was the main reason for the low incidence of anastomotic leakage in our series. In the first case, we suspected an upper pouch fistula during the operation. The upper pouch is usually tightly connected to the trachea, and accidental opening of the upper pouch or the trachea is sometimes possible during preparation [1, 6]. In that case, separation of the upper pouch from the trachea results in accidental opening of the upper pouch and trachea, which requires additional sutures. In some centers, preoperative tracheoscopy is a standard procedure, but we do not do this routinely. We left the drain in the pleural cavity only during the first 3 operations; subsequently, we left the patients without drainage. In our opinion, when leakage or pneumothorax is suspected, additional drainage must be inserted because primary drainage is usually occluded. The patients stayed in the intensive care unit for 10 days after the operation and when the contrast study confirmed normal passage through the anastomosis. Patients were then transferred to the surgical clinic and oral feeding was introduced [7].

Surgical repair was performed by 1 surgeon with 14 years of experience in minimally invasive surgery and experience with intra-corporeal suturing, but the learning curve was obviously visible in the successive operations, although the duration of the operation did not diminish markedly. Borruto *et al.* performed a meta-analysis comparing patients with esophageal atresia and trachea-esophageal fistula treated thoracoscopically and by thoracotomy [8, 9]. They concluded that the outcomes using the thoracoscopic approach are similar to those with open surgery. The most common complications, i.e. leaks and strictures, were comparable in both groups [10]. The cosmetic effect and low rate of scoliosis associated with the thoracoscopic approach are well-known advantages, and may convince pediatric surgeons to use the technique wore widely [11, 12].

Conclusions

In our opinion, thoracoscopic repair should be the operation of choice in congenital esophageal atresia because of the excellent visualization associated with magnification of the operative field. Of course, this technique requires experience in minimally invasive surgery, especially in neonatal surgery, so only a few pediatric surgeons are able to gain proficiency in this operation.

Conflict of interest

The authors declare no conflict of interest.

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