Journal of Pediatric Surgery 53 (2018) 121–125

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

Thoracoscopic management of non-type C esophageal atresia and tracheoesophageal atresia☆

Steven S. Rothenberg *

Rocky Mountain Hospital for Children, Denver, CO

ARTICLE INFO

Article history:
Received 24 September 2017
Accepted 5 October 2017

Keywords:
Esophageal atresia
Tracheoesophageal atresia
H-type fistula
Long gap
Thoracoscopy

ABSTRACT

Purpose: This study evaluates the results of thoracoscopic management of complex, non-type C, EA and TEF in infants.
Methods: From March 2000 to February 2017, 23 patients were treated for Type A N = 13, Type B N = 4, and Type E N = 6. Patients diagnosed with EA had G-tube feeds for a period of 4–9 weeks. All procedures were performed thoracoscopically. EA gaps were between 4 and 7 1/2 vertebral bodies.
Results: All surgeries were completed thoracoscopically. Average operative time was 95 min for Type A, 115 min for Type B, and 50 min for Type E. Two patients with long gaps had small leaks which resolved with conservative management. One patient with an H-type was re-intubated causing a partial disruption of the tracheal repair. This required thoracoscopic re-exploration with repair and placement of an intercostal muscle flap. No patient has any clinical evidence of fused ribs, chest wall asymmetry, shoulder girdle weakness, or winged scapula.
Conclusion: Thoracoscopic repair of complex EA and TEF is safe and effective. The excellent visualization of the thoracic inlet allows for extensive mobilization creating sufficient length for long gaps and safely managing high fistulas. This may limit injury to adjacent structures and avoid a neck incision and chest wall deformity.
Level of evidence: IV.

© 2017 Elsevier Inc. All rights reserved.

Neonates with non-type C esophageal atresia (proximal pouch with distal fistula) present one of the most technically challenging and difficult management problems that pediatric surgeons have to manage. Type A (pure esophageal atresia EA), Type B (proximal fistula with distal pouch), and Type D (proximal and distal fistulas), have traditionally been managed by thoracotomy while Type E (H-type fistula) has been approached through a neck incision. Patients with types A and B often have long gaps (greater than 4 vertebral bodies) which have been managed by various techniques including spontaneous growth, esophageal elongation procedures, and esophageal replacement procedures.

In cases of long gap most surgeons would agree that salvaging the native esophagus is preferable, if possible, and many extreme measures have been used to accomplish this. The primary issue is attaining enough length to perform an adequate anastomosis without causing significant morbidity.

Ever since the first successful thoracoscopic repair of a pure EA in 1999 [1] and the first thoracoscopic tracheoesophageal fistula (TEF) in 2000 [2] we have used a thoracoscopic approach for all patients with Type A, B, and C. In 2009 we adopted a similar approach for Type E fistulas. This article describes a single institution's experience with long gap EA and H type fistulas using only the thoracoscopic approach.

1. Materials and methods

From March 2000 to March 2017 23 patients with Non-type C EA +/−TEF were repaired by or under the direct supervision of the author. This included 13 patients with Gross classification type A, 4 patients with type B, and 6 patients with type E. No patients with type D were encountered during the study period. No patient was excluded based on gap length or associated anomalies. All patients with type A and B initially underwent placement of a gastrostomy tube (G-tube). All patients were then kept in the Level 2 nursery to allow for growth and upper pouch suctioning. The gap length was evaluated approximately every 2–3 weeks by contrast G-tube study with slight downward pressure placed on the nasogastric tube (Fig. 1).

These patients were operated on between 4 to 8 weeks of age at the discretion of the surgeon. Factors considered included patient size, overall condition, and a failure to show any improvement in gap length.

☆ Dr. RothenbergWas responsible for study conception and design
- acquisition of data
- analysis and interpretation of data
- drafting of manuscript

* Chief of Pediatric Surgery, The Rocky Mountain Hospital for Children, 2055 High Street, Suite 370, Denver, CO 80111. Tel.: +1 303 839 6001; fax: +1 303 839 6033.
E-mail address: steverberg@aol.com (S.S. Rothenberg).

https://doi.org/10.1016/j.jpedsurg.2017.10.025
0022-3468/© 2017 Elsevier Inc. All rights reserved.

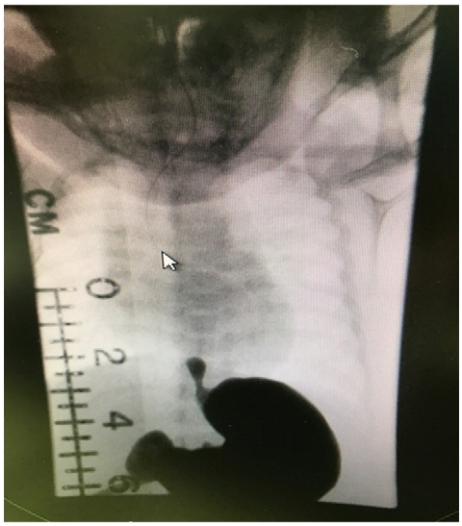

Fig. 1. UGI at 7 weeks of age shows a 6 vertebral body gap with downward pressure on the NG tube and contrast placed through the G tube. The white arrow shows the tip of the upper pouch.

Patients with gaps over 6 vertebral bodies were allowed to grow for 6–8 weeks prior to operation. Many of the patients were premature (32–37 weeks gestation), but all repairs were done before they reached a corrected gestational age of 46 weeks. Patient weights ranged from 2.6 to 3.9 kg at the time of surgery. One patient was referred at 3 months of age and already weighed 4.2 kg. This patient had a gap of 5.5 vertebral bodies and a previously undiagnosed upper pouch fistula. Eight patients had significant associated congenital anomalies (VACTERL), 6 with major congenital heart defects, 2 with imperforate anus (treated initially by colostomy) and 8 with vertebral and limb anomalies. One patient had a horseshoe kidney. Gap length, as measured by G tube contrast study ranged from 4 to 7 1/2 vertebral bodies with a mean of 5 1/2. The longest gap at the time of surgery was measured to be 7 1/2 vertebrae.

The repairs were performed using a three-port technique as previously described [3,4]. In 15 cases the procedure was performed via a right thoracoscopy, and in 2 a left because of a right sided aortic arch. Mobilization of the upper pouch was carried up through the thoracic inlet and well up into the neck on the upper pouch (Fig. 2).

The lower pouch was mobilized as much as necessary to achieve the anastomosis. In most cases this was down to the esophageal hiatus; however, the hiatus was not breached in any case. All patients with presumed EA underwent bronchoscopy prior to thoracoscopy to search for the presence of an upper pouch fistula. This was found in 4 patients (23.5%). The upper pouch fistula was divided and sutured in 2 patients, in 2 others it was divided with a 5MM endoscopic stapler after it became available in 2015. The esophageal anastomosis was sutured with a monofilament absorbable suture placed in a single interrupted fashion (Fig. 3).

A transanastomotic tube and chest drain were left in all cases of EA. The six patients with type E fistulas presented between 2 and 12 weeks of age and underwent division thoracoscopically. Two were divided and sutured, 2 were clipped and divided, and 2 were divided with the 5 mm stapler (JustRight Surgical; Louisville, Co) (Fig. 4 a,b).

Tissue was interposed as much as possible in each case. The pleura was also closed to prevent pleural contamination in case of a leak. No chest drain was left in these cases and all patients were extubated immediately post-operatively.

2. Results

All 23 procedures were completed successfully thoracoscopically. Operative times ranged from 45 to 135 min. The average operative time for type A was 95 min (range 60–120), 115 min for type B (range 75–135), and 50 min (range 45–75) for type E. Twelve of 17 patients with types A and B had significant tension on their anastomosis at the time of surgery and were therefore kept intubated and paralyzed for 5 days. A contrast study was obtained on day 5 to evaluate for a leak. The average length of intubation in this group was 7 days with the longest interval being 15 days in a type A patient who demonstrated a leak.

In the other 5 patients with long gap, the tension was felt to be minimal, and the patients were extubated, three on day two, one on day three, and two on day four. These patients also had contrast studies on day 5 and none showed evidence of a leak.

There were 2 esophageal leaks in the long gap patients (11.7%), one each in the type A and B patients. Both resolved with conservative nonoperative therapy. Gastrostomy feeds were started on Day 5 in all other patients. Eight of 17 patients (47%) required dilations (1, 8, to), these were started as early as 3 weeks post-operatively and in one patient occurred 8 times over the period of 11 months. Eight of these patients (47%) required a Nissen fundoplication for severe reflux. Two patients required a second Nissen for a hiatal hernia at 6 months and 1 year after the initial fundoplication. Sixteen of 17 patients are currently on full oral feeds (Follow-up 2 months to 16 years, avg. 46 months). The exact range of time to full oral feeds was not well documented in the charts but ranged from 4 weeks to 10 months' post repair. The last patient with Type A is 8 weeks post-procedure at the time of this manuscript preparation and remains on full G-tube feeds but is working on oral feeds.

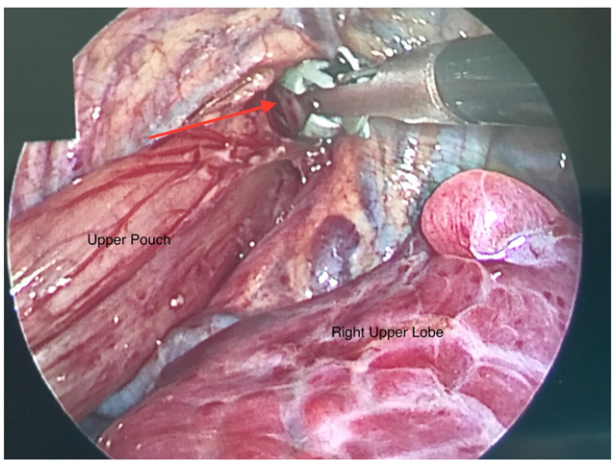

Fig. 2. Thoracoscopic view showing dissection of the upper pouch up into the neck. The red arrow shows the 3 mm sealer dissecting up past the thoracic inlet to obtain mobilization and length on the upper pouch.

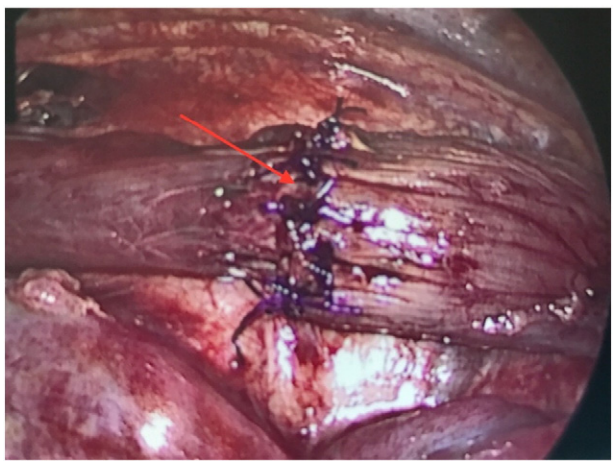

Fig. 3. Thoracoscopic view of completed anastomosis (red arrow). The upper pouch was mobilized and pulled down into the lower third of the thoracic cavity.

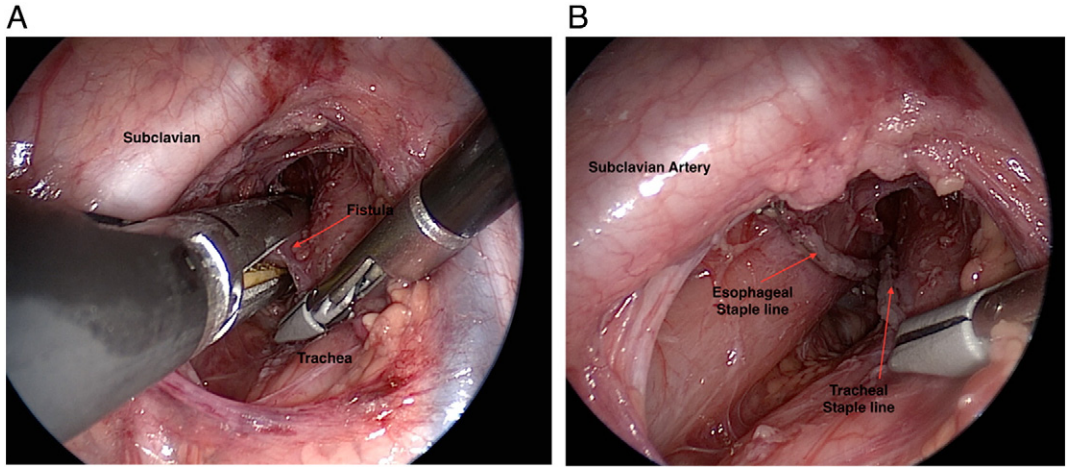

Fig. 4. A, Placement of the 5 mm stapler across an H-type fistula well above the clavicle. The arrow points to the fistula. B, The divided fistula and the 2 staple lines (red arrows point to esophageal and tracheal staple lines).

Five of the 6 patients with H type had contrast studies on day 2 and showed no leak. They resumed oral feeds that day and were discharged from the hospital on post-op day 2. The 6th was re-intubated the evening of surgery causing a partial disruption of the tracheal repair. This was identified by a small pneumothorax. This required thoracoscopic re-exploration with repair and placement of an intercostal muscle flap. A repeat study showed no leak. This patient was discharged on post-operative day 10. Follow-up in this group ranges from 2 to 72 months and there is no evidence of a recurrent fistula in these patients.

One patient with type A has a right vocal cord paresis (4%) which is improving with time (F/U 10 months). Patients were only evaluated for this if there was clinical stridor post-operatively. No patient has any evidence of chest wall asymmetry, winged scapula, shoulder girdle weakness, or clinically significant scoliosis.

3. Discussion

The management of patients with long gap EA remains a significant challenge. Most pediatric surgeons agree that all attempts should be made to preserve the esophagus initially although timing and approach are not widely agreed on. Spitz [5] has suggested that in some cases of extreme long gap a primary anastomosis is not the best treatment and that a gastric pull-up may be the better option, performed at 2–3 months of age. However, initial management at most institutions is placement of a gastrostomy button, upper pouch suctioning, and growth, with intermittent gap studies [6,7]. Many different techniques have been advocated to induce esophageal growth. These have included upper and lower pouch stretching with bougies and the procedure of Kimura and Soper [8] with upper pouch elongation by serial stretching on the anterior chest wall. Other surgical approaches have included the use of circular myotomies or flaps [9,10]. More recently a great deal of attention has been given to dynamic stretching with traction sutures (the Foker Procedure FP), which attempts to achieve esophageal continuity, but requires multiple open thoracotomies and a variable period of growth before the first procedure is performed [11]. Bairdain et al. reported on their recent series and showed the average time to initiating the FP after admission to their hospital averaged 24 days (range 1–144) with an average of 14 days and 2 (range 2–10) thoracotomies to achieve an anastomosis [12]. This procedure has also been performed thoracoscopically with mild modifications [13]. Unfortunately, all the procedures have variable success and can be associated with significant short- and long-term morbidity as well as prolonged ICU and hospital stays.

Since the first thoracoscopic repair of a pure EA in 1999 and EA w TEF in 2000, we have used this approach as our primary technique for patients. This approach, which has been modified slightly over the last decade, provides excellent visualization and exposure, especially in this group of patients who tend to be operated on when they are slightly larger (average, 3.4 kg), rather than the type C patients who are operated on as newborns.

This exposure allows for direct visualization and dissection up into the neck to the level of the Thyroid and beyond. We believe this technique allows greater mobilization and therefore achieves greater length of the upper pouch than when done through an open thoracotomy, thus allowing a higher incidence of a successful repair with a single operation.

Because of our early experience with thoracoscopic mobilization of the upper pouch in type A patients we felt we could approach type B, D, and E patients this way as well. The thought was that direct visualization and access to a fistula high in the thoracic inlet could be achieved, avoiding a neck incision and perhaps decreasing the incidence of recurrent laryngeal nerve injury. While most studies report an incidence of 3–5% of vocal cord paresis on patients with TEF and EA atresia [14] following repair, studies which look specifically at Type B and E show much higher rates. This includes a rate of 36% reported by Conforti et al. [15] in types B and E patients to as high as 50% by Zani et al. [16]. This approach also avoids the morbidity and cosmetic disadvantage of a neck incision. In all cases, we found the fistula was easily identified, mobilized, and divided thoracoscopically due to the significant magnification afforded by the scope and HD camera. Suturing high in the thoracic inlet is technically challenging but the availability of a 5 mm endoscopic stapler has made this maneuver much easier and quicker.

When approaching these complex esophageal procedures thoracoscopically there are a few key technical steps which greatly add to a successful outcome. The patient should be placed in a modified lateral decubitus position, tilted forward approximately 45 degrees. This allows the lung to fall forward once collapsed by the CO2, giving excellent exposure to the posterior mediastinum and apex of the chest. The scope port should be placed behind the tip of the scapula in the 4th or 5th interspace, this allows the best exposure for the upper pouch and dissection into the neck, which is crucial in cases of long gap and H type fistulas. The right and left operating ports should then be placed in the axilla and slightly below and posterior to the scope port, so that the right and left hands are relatively at 90 degrees to each other for the apical dissection, and fistula ligation if present, as this is the most difficult portion of the procedure. Dissection should stay directly on the esophageal wall to avoid injury to surrounding structures and monopolar cautery should be avoided up in the apex of the chest and during the neck dissection as much as possible. We have found the 3 mm vessel sealer to be perfect for this part of the dissection as it nearly eliminates thermal spread high in the neck. A plane between the esophagus and membranous portion of the trachea should be established below the level of the fistula, this

can then easily be followed up until the fistula is reached, preventing unwarranted dissection and possible injury to surrounding structures, including the vagus and recurrent laryngeal nerves.

This study also reinforces the importance of bronchoscopy in patients with presumed pure atresia. The incidence in this study approached 25%, much higher than previously reported [17].

Another important technical point is the ability to mobilize the distal pouch all the way down to the hiatus under direct vision. Some have expressed concerns about devascularizing the lower pouch with extensive mobilization, but others have documented this can be done safely, and we have not found this to be an issue [18]. We believe the 1–2 months months of bolus G-tube feeds prior to surgery dilates and thickens the lower pouch, giving the tissue more integrity under tension, when the anastomosis is finally attempted.

The last major technical advantage over a thoracotomy is the ability to perform the anastomosis in situ with the chest closed. We believe this diminishes the gap length and tension on the anastomosis. It is likely this is only a slight benefit, but in these patients with long gaps millimeters may be the difference between success and failure.

The major difficulty of this technique in patients with long gaps is that all the tension is placed on one suture at a time as opposed to laying in multiple sutures and spreading the tension over many, but in general this has not been a problem. If it appears that a stitch is starting to tear through the esophageal wall, the stitch is left loose with a surgeon's knot and a second stitch is placed to spread the tension. Others have advocated placing corner-stay sutures that are brought out through the chest wall to help approximate the ends and spread the tension [19]. There are also other techniques that can be used to avoid the problem of all the tension on one stitch but we have not found this necessary.

To date we have not had to re-operate on any of the anastomoses for leak or stricture, nor have we required more than 1 procedure to get the ends together and complete the anastomosis. The stricture rate requiring dilation is about 40%, which is not surprising. However, all patients have responded favorably to dilation.

Gastroesophageal reflux disease (GERD) is a significant problem in this group of patients, and this is also not surprising. Nearly 50% have required a fundoplication, and the redo rate stands at over 20%, this is likely to go higher. These figures are similar to that of other series. However, the morbidity of a laparoscopic fundoplication in this patient cohort has been low both for primary and redo procedures. Hiatal hernia is a significant issue and is likely secondary to the short esophagus. Currently no patient has required an alternative procedure such as a Collis-Nissen to lengthen the esophagus. A key to this may be the fact that we never breach the esophageal hiatus leaving the phrenoesophageal ligaments intact. This may help prevent development of a hiatal hernia and encourage growth of the lower esophageal segment.

We have also used this technique in patients with Type C TEF and gaps of over 4 vertebral bodies [20]. These tend to be patients with trifurcation fistulas and short upper pouches, however we do not believe that patients with a lower pouch fistula meet the criteria for long gap and so they were not included. We have been able to achieve a 1 stage thoracoscopic repair in all of these patients.

There is no question that there are patients whose gap is so long, and proximal and distal pouches so small, that a primary anastomosis could not be achieved even after a period of growth. Our longest gap to date is 7 1/2 vertebrae, and it is likely that a much longer gap would be difficult if not impossible to bridge. If we could not bridge the gap with the primary procedure we would mobilize the two ends extensively and place a single stitch between the two ends under moderate tension to draw them together. We would then perform a repeat thoracoscopy at 10 to 14 days to see if we could achieve the anastomosis. A similar technique has been advocated by van der Zee [21] although they now perform the first procedure in the first 2 weeks of life. Our concern with this technique is that they are committing the patients to multiple procedures. However, they avoid the morbidity of repeat thoracotomies and may achieve continuity of the esophagus sooner than using our approach. Further numbers will be necessary to fully evaluate this approach. If we were unable to bring the ends together we would agree with Spitz [5] and do a primary gastric pull-up, but not until we proved that an anastomosis could not be achieved thoracoscopically.

We believe that a period of growth of 1–2 months with G-tube feeds, followed by a thoracoscopic approach for anastomosis, provides the optimal approach in patients with a long gap EA and avoids much of the morbidity of early intervention, including multiple open thoracotomies and prolonged intensive care unit stays [12].

As for Type E or H type fistulas, a thoracoscopic approach is now our preferred technique. While the issue is not avoiding a thoracotomy as most of these are approached via a neck incision, we feel the improved visualization offers significant advantages and may decrease the risk of recurrent laryngeal nerve injury. These patients did not require chest drains and have been discharged in under 48 h. In truth they probably could have been discharged on post-op day one but we kept them to obtain a study on day 2. Many have expressed concern about not being able to reach the fistula via thoracoscopy but in our experience this has not been the case. It can be technically challenging to suture in this area, but we believe the improved visualization outweighs the disadvantages. The recent availability of a 5 mm endoscopic stapler greatly facilitates safe division on the fistula and has significantly shortened the operative time. Also, the cosmetic benefits of avoiding a neck incision are obvious. Trans-thoracic and trans-axillary approaches have now become popular in thyroid and parathyroid surgery for similar reasons and it seems reasonable to avoid a potentially disfiguring neck incision in these infants if the procedures are comparable.

Lastly, while the primary goal in these operations is to obtain continuity of the esophagus, there is no denying the morbidity of a thoracotomy, let alone multiple procedures [22]. Our belief is if this can be avoided with equal or perhaps superior results then it is preferable to allow a period of growth and achieve continuity of the esophagus in a single stage thoracoscopic approach.

Appendix A. Discussions

Presented by Steven Rothenberg, Denver CO.

AGOSTINO PIERRO (Toronto, ON) Steve, this is fantastic. Congratulations for your skill. This is obviously a very controversial issue, how to repair the pure atresia, which is part of your group. Can I ask you, when you assess the gap between the two esophageal pouches, do you actually push the gap, or do you actually measure it without pushing because that could make the gap significantly different.

STEVEN ROTHENBERG Everyone has a different method of doing this, and the documentation is different. What I do is when we study them we push, apply pressure on the nasogastric tube, but we simply inject contrast through the G-tube, so I understand that that might underestimate the length of the lower pouch, but it's consistent and that's what we're working for. It could be that some of these gaps would be shorter, but when we explore them thoracoscopically, there are certainly over four vertebral bodies between those. I know some people put in an endoscope, some people put in bougies. I think what's important is that you are consistent. We've used this technique in all of our patients. It's not a huge series, but it seems to have worked relatively well.

AGOSTINO PIERRO And in terms of the H-type fistula, which could be actually with an esophageal atresia quite high in the neck, do you think that the thoracoscopic approach is preferable to a neck approach in that case?

STEVEN ROTHENBERG I do because many of the cases, two of which I′ve done in other centers than mine, and they said the fistula is too high, we don't think we can get to it. The fistulas are actually usually in the same place. They're all at the thoracic inlet,

usually above the clavicle, but the exposure you get from a thoracoscopic approach is really quite amazing, and as in your paper where you quote there was I think over a 30% injury to recurrent laryngeal nerves, I think you see the nerve better. I think you are able to dissect out the fistula, protecting the vagus and hopefully recurrent laryngeal nerves, and so my hope is that not only will you avoid the cosmetic defect of a neck incision but will protect the nerves better, so I think it is a preferable approach.

AGOSTINO PIERRO Very interesting.

UNIDENTIFIED SPEAKER Steve, is there ever a time that you think the gap or that you encounter where the gap you felt was too long, that you would do something different?

STEVEN ROTHENBERG I have not. I'm sure that will happen, so I wanted to publish this before it did (laughter). So if I did get in and after extensive mobilization, I could not get the two ends together, and when I get the two ends together I mean sometimes they are just coming together with the initial stitch, I would leave that internal traction suture and come back at 10–14 days to see, because some of my colleagues who are doing this younger, there are two places in Europe, they're saying they're actually going in primarily on pure atresias and doing this and doing an internal traction suture, but I would do that. I am convinced that I will come across a case where there's just a gap I can't bridge, and at that point I would probably abandon that and plan to do a gastric pull-up.

UNIDENTIFIED SPEAKER Steve, one quick question. When you do the thoracoscopic approach for the H-type, do you also before it place a stent as we typically do in the open? Or no stent?

STEVEN ROTHENBERG I always did when I did it open. Now that I do it thoracoscopically I do not because I can see it so well. I think if you're used to doing it, and you want it to help you if you're not comfortable identifying it the first time, especially I think if you do the U technique where you put it in and then bring it back up so that you can pull on it, it might help you identify it. But you're actually – the trick is to find the back wall of the trachea, follow that up the plane between the esophagus and the trachea – and it's always been quite easy to identify the fistula, so the only thing that putting the stent in is taking up time preoperatively, so I've quit doing it.

References

[1] Lobe TE, Rothenberg SS, Waldschmidt J, et al. Thoracoscopic repair of esophageal atresia in an infant: a surgical first. Pediatr Endosurg Innov Tech 1993;3:141–8.
[2] Rothenberg SS. Thoracoscopic repair of tracheoesophageal fistula in a newborn. Pediatr Endosurg Innov Tech 2000;4:289–94.
[3] Rothenberg SS. Thoracoscopic repair of tracheo-esophageal fistula. Semin Pediatr Surg 2005;14:2–7.
[4] Holcomb GW, Rothenberg SS, et al. Thoracoscopic repair of esophageal atresia and tracheoesophageal fistula: a multi-institutional analysis. Am J Surg 2005; 242:1–9.
[5] Spitz L. Esophageal atresia, lessons I have learned in a 40 year experience. J Pediatr Surg 2006;41:1635–40.
[6] Koivusalo AI, Mikko PP, Rintala RJ. Modern outcomes of oesophageal atresia: single centre experience over the last 20 years. J Pediatr Surg 2012;48:297–303.
[7] Zani A, Cobellis G, Wolinska J, et al. Preservation of native esophagus in infants with pure esophageal atresia has a good long-term outcomes despite significant postoperative mortality. Pediatr Surg Int 2016;32:113–7.
[8] Kimura K, Soper RT. Multistaged extrathoracic esophageal elongation for long gap esophageal atresia. J Pediatr Surg 1994;29:566–8.
[9] Gough MH. Esophageal atresia—use of an anterior flap in the difficult anastomosis. J Pediatr Surg 1980;15:310–1.
[10] Lai JY, Sheu JC, Chang PY, et al. Experience with distal circular myotomy for long-gap esophageal atresia. J Pediatr Surg 1996;31:1503–8.
[11] Foker JE, Linden BC, Boyle EM, et al. Development of true primary repair for the full spectrum of esophageal atresia. Ann Surg 1997;226:533–43.
[12] Bairdain S, Hamilton TE, Sithers CJ, et al. Foker process for the correction of long gap esophageal atresia: primary treatment versus secondary treatment after prior esophageal surgery. J Pediatr Surg 2015;50:933–7.
[13] Van der Zee DC, Vierra-Travassos D, Kramer WL, et al. Thoracoscopic elongation of the esophagus in long gap esophageal atresia. J Pediatr Surg 2007;42:1785–8.
[14] Mortellaro VE, Pettiford JN, St Peter SD, et al. Incidence, diagnosis, and outcomes of vocal fold immobility after esophageal atresia (EA) and/or tracheoesophageal fistula (TEF) repair. Eur J Pediatr Surg 2011;21:366–8.
[15] Conforti A, Iacusso C, Valfre L, et al. Cervical repair of congenital tracheoesophael fistula: complications lurking. J Pediatr Surg 2016;51:1623–6.
[16] Zani A, Jamal L, Cobellis G, et al. Long=term outcomes following H-type tracheoeosophageal fistula in infants. Pediatr Surg Int 2017;33:187–90.
[17] Bax KN, Roskott AM, van der Zee DC, et al. J Pediatr Surg 2008;43:522–5.
[18] Lessin MS, Wesselhoeft CW, Luks FI, et al. Primary repair of long-gap esophageal atresia by mobilization of the lower pouch. Eur J Pediatr Surg 1999;9:369–72.
[19] Shimotakahara A, Sueyoshi R, Lane GJ, et al. The benefit of stay sutures during thoracoscopic esophagoesophagostomy in patients with esophageal atresia: a technical report. Pediatr Surg Int 2010;26:443–6.
[20] Rothenberg SS. Thoracoscopic repair of esophageal atresia and tracheo-esophageal fistula in neonates: evolution of a technique. J Laparoendosc Adv Surg Tech A 2012;22:195–9.
[21] van der Zee DC, Gallo G, Tygat SH. Thoracoscopic traction technique in long gap esophageal atresia: entering a new era. Surg Endosc 2015;29:3324–30.
[22] Lawal TA, Gosemann JH, Kuebler JF, et al. Thoracoscopy verses thoracotomy improves midterm musculoskeletal status and cosmesis in infants and children. Ann Thorac Surg 2009;87:224–8.