Received: 12 February 2019 | Revised: 6 March 2019 | Accepted: 9 April 2019

DOI: 10.1111/ases.12714



Asian Journal of Endoscopic Surgery
Official Journal of JSES, ELSA, and AETF

WILEY

ORIGINAL ARTICLE

# Thoracoscopic approach for complications after esophageal atresia repair: initial experience

**Indalecio Cano Novillo**[1] | **Belén Aneiros Castro**[2] | **Jorge Godoy Lenz**[3] | **Maria Consuela Puentes Rivera**[4] | **Araceli García Vázquez**[1] | **Cecilia Moreno Zegarra**[5]

[1]Department of Pediatric Surgery, Hospital 12 de Octubre, Madrid, Spain

[2]Department of Pediatric Surgery, Hospital Álvaro Cunqueiro, Vigo, Spain

[3]Department of Pediatric Surgery, Clínica Las Condes, Santiago de Chile, Chile

[4]Department of Pediatric Surgery, Hospital San Juan de Dios, Santiago de Chile, Chile

[5]Department of Pediatric Surgery, Hospital Universitario de Salamanca, Salamanca, Spain

**Correspondence**
Belén Aneiros Castro, Department of Pediatric Surgery, Álvaro Cunqueiro Hospital, Calle de Clara Campoamor, 341, 36312 Vigo, Spain.
Email: belenaneiroscastro@gmail.com

**Funding information**
This research was not supported by a specific grant from any funding agency in the public, commercial, or not-for-profit sector.

## Abstract

**Introduction:** Improvements in technology and health care have helped reduce morbidity and mortality in patients with esophageal atresia. However, postoperative complications such as dehiscences, strictures, and recurrent fistulas still occur in a large percentage of patients. Here, we present our initial experience using the thoracoscopic approach for complications after esophageal atresia repair.

**Methods:** We retrospectively analyzed the medical records of patients who developed complications after esophageal atresia repair and underwent thoracoscopic reoperation at two centers. Anastomotic leakage, anastomotic stricture, and recurrent tracheoesophageal fistula were assessed as complications after esophageal atresia repair.

**Results:** We reoperated on four patients (range of age 3 days - 2 years) by thoracoscopy. Two patients who had undergone thoracoscopic atresia repair presented with anastomotic dehiscence. The anastomoses were thoracoscopically reconstructed without tension. One patient had undergone thoracoscopic atresia repair presented with esophageal stricture refractory to endoscopic dilatations. Thoracoscopic esophagoesophagostomy was performed in this 2-year-old patient. One patient who had undergone esophageal atresia repair and tracheoesophageal fistula closure by thoracotomy presented with a recurrent fistula at 1 year of age. The patient underwent thoracoscopic fistula closure with a 5-mm endostapler. All patients remain asymptomatic after reoperation.

**Conclusions:** Reoperation after esophageal atresia repair is challenging and carries a relatively high risk of developing complications. Compared to conventional surgery, the thoracoscopic approach in experienced hands offers better visualization and more accurate dissection and drainage of the thoracic cavity. Therefore, we want to encourage the use of thoracoscopy in the treatment of complications after esophageal atresia repair.

**KEYWORDS**
complications, esophageal atresia, thoracoscopy

## 1 | INTRODUCTION

Technological advances have significantly influenced improvements in perinatal intensive care in recent decades. New therapies have had an important, positive impact on mortality rates in patients with esophageal atresia (EA).[1] However, postoperative complications still occur in a large percentage of patients. Anastomotic dehiscence, esophageal stricture, and recurrent tracheoesophageal fistula (TEF) are among the most common complications after EA repair.[2] These complications may have great relevance to the short- and long-term outcomes of patients who have undergone EA.[2,3]

Minimally invasive techniques have revolutionized surgery by offering certain benefits over conventional procedures, such as less postoperative pain, shorter hospital stay, and superior cosmetic results. The thoracoscopic approach is a widely accepted technique for EA repair. It offers excellent anatomic visualization, which enables accurate dissection and exposition of the esophageal structures and reduces the possibility of iatrogenic lesions. This approach avoids large incisions, minimizing the risk of musculature damage, thoracic asymmetry, and scoliosis.[1] Despite these advantages, the thoracoscopic approach is not yet a well-established procedure for the treatment of complications after initial EA repair. Here, we present our initial experience with the thoracoscopic approach for early and late complications after EA repair.

## 2 | MATERIAL AND METHODS

We retrospectively evaluated the medical records of patients with complications after EA repair who had undergone thoracoscopic surgery at two centers between 2014 and 2018. Preoperative data included gestational age, age at surgery, gender, type of EA according to Gross classification, and indications for reoperations. Operative data included intraoperative findings, thoracoscopic techniques used, and complications. Postoperative data included days to start of oral intake, length of hospital stay, postoperative radiological test findings, complications, and follow-up. The ethics committee (Hospital 12 de Octubre) approved the study. Patient data are summarized in Table 1.

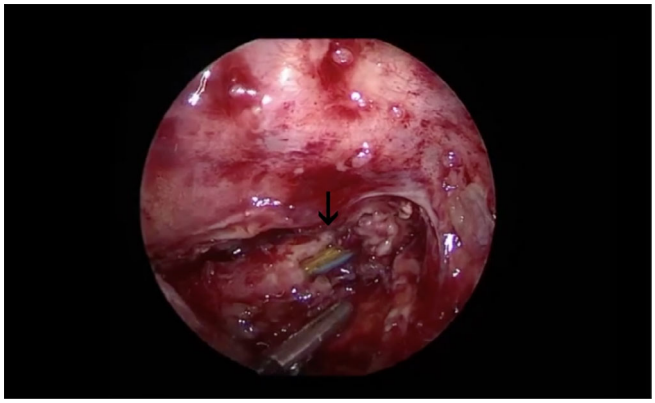

**FIGURE 1** Anastomotic dehiscence (arrow) after thoracoscopic esophageal atresia repair

Anastomotic leakage, anastomotic stricture, and recurrent TEF were assessed as complications after EA repair. Anastomotic leakage was defined as extravasation of esophageal contents or contrast into the mediastinum. Anastomotic stricture was defined as symptomatic narrowing of the esophageal anastomosis requiring dilatation. Recurrent TEF was defined as the presence of a fistula in the same location where the TEF was closed during the surgical repair.

## 3 | RESULTS

### 3.1 | Patient 1

A full-term baby (weight: 2.9 kg) presented with type C EA. Thoracoscopic EA repair and TEF closure were performed without complications at birth. Dehiscence was suspected on postoperative day 3 because of the presence of saliva in the drainage tube. Therefore, an esophagogram was ordered. Leakage of contrast was observed so a thoracoscopic reoperation was performed. After the adhesions were removed, an esophageal dehiscence was found (Figure 1). The anastomosis was partially reconstructed with Prolene 6-0 (Ethicon, INC., Somerville, New Jersey). Anastomotic tension was lower than in the first surgery. No leak or stenosis was observed in the contrast study. The patient started feeding on postoperative day 7 and was discharged home on postoperative day 10. No postoperative complications were found. Currently, at 4 years of follow-up, he is asymptomatic.

**TABLE 1** Patient data

| Patients | Primary approach | Complications | Age at reoperation | Reoperation technique |
|---|---|---|---|---|
| 1 | Thoracoscopy | Dehiscence | 3 d | Partial re-anastomosis |
| 2 | Thoracoscopy | Dehiscence | 5 d | Partial re-anastomosis |
| 3 | Open | Recurrent TEF | 2 y | TEF closure |
| 4 | Thoracoscopy | Stenosis | 2 y | Resection of stenosis and re-anastomosis |

TEF, tracheoesophageal fistula.

## 3.2 | Patient 2

A full-term baby (weight: 3.2 kg) presented with type C EA. He underwent thoracoscopic EA repair and TEF closure at birth. There were no intraoperative complications. Esophageal contents were observed through the drainage tube on postoperative day 5. A contrast study showed contrast leakage in the mediastinum so we decided to perform a thoracoscopic reoperation. An anastomotic dehiscence was observed. We resected the edges of the dehiscence and performed a partial esophageal re-anastomosis with Prolene 6-0. In this case, anastomotic tension was also lower than in the primary repair. No leak or stenosis was observed in the postoperative contrast study. The patient stared oral intake on postoperative day 7 and was discharged home on postoperative day 10. No postoperative complications were found. Currently, at 2 years of follow-up, he is asymptomatic.

## 3.3 | Patient 3

A 22-month-old male patient was referred because of suspicion of recurrent TEF. He underwent open extrapleural EA repair and TEF closure on the third day of life. No dehiscence or leakage was observed in the postoperative contrast study. However, the patient had several episodes of bronchiolitis and coughed during feeding. Therefore, a new esophagogram was performed, but no TEF was found. Clinical symptoms persisted so a bronchoscopy was performed, and it confirmed a TEF at the carina level. We attempted an endoscopic TEF closure using 50% trichloroacetic acid. The patient was discharged on postoperative day 2. At follow-up shortly thereafter, improvement was observed, but occasional symptoms persisted. A second attempt to close TEF with trichloroacetic acid was proposed, but the patient's parents refused the procedure. Therefore, surgical repair was planned.

During surgery, we used a 5-mm port for the scope and three 3-mm ports for the instruments. Although the first approach was extrapleural, adhesions were found. We removed these adhesions and dissected the esophagus with monopolar electrocautery. Once TEF had been identified, a belt was passed around it to support the dissection. We closed the TEF with a 5-mm endostapler (MicroCutter 5/80; Dextera Surgical Inc., Redwood City, CA) (Figure 2). A flap of pleura was interposed to avoid contact between the two staple lines. No chest drain was placed, and the patient was extubated at the end of the surgery. Postoperative chest radiography was normal. The patient started feeding the day after surgery. He did not present any symptom so he was discharged on postoperative day 3. Currently, at 12 months of follow-up, he is asymptomatic.

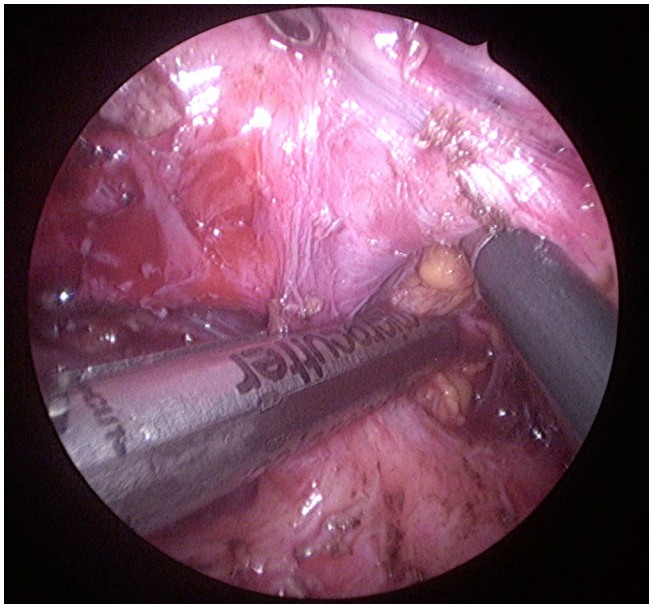

**FIGURE 2** Thoracoscopic tracheoesophageal fistula closure with a 5-mm endostapler

## 3.4 | Patient 4

A preterm patient with type A EA underwent open gastrostomy at birth. Because of the length of the gap between the esophageal segments, surgeons decided to perform a delayed anastomosis. There was a dehiscence of the gastrostomy tract that required redo open gastrostomy. At 3 months of age, the patient was referred and underwent thoracoscopic esophageal anastomosis under tension. Follow-up contrast study of the esophagus showed an anastomotic stricture. Endoscopic dilatations were performed once or twice a month depending on clinical symptoms.

At 2 years of age, the stricture persisted so we decided to perform thoracoscopic repair. The ports were placed in the same locations used in the first thoracoscopy. We placed an accessory port to help with tissue separation. After the dissection of the distal pouch was completed, a belt was passed around the esophagus to help retraction and proximal dissection. A complete stenosis with thick fibrous tissue was found at the level of the previous anastomosis (Figure 3). We resected the anastomotic stricture and performed an end-to-end anastomosis without tension. The anastomosis was performed over a 10-Fr. nasogastric tube with interrupted Vicryl 5-0 sutures (Ethicon, INC., Somerville, New Jersey). The patient was intubated with muscle relaxation for 4 days. After 1 week, a contrast esophagram was performed. No stenosis was observed, and she started feeding without difficulty. A month after surgery, endoscopy was performed. It showed an adequate esophageal caliber so dilatation was not required. Currently, at 14 months of follow-up, she is asymptomatic.

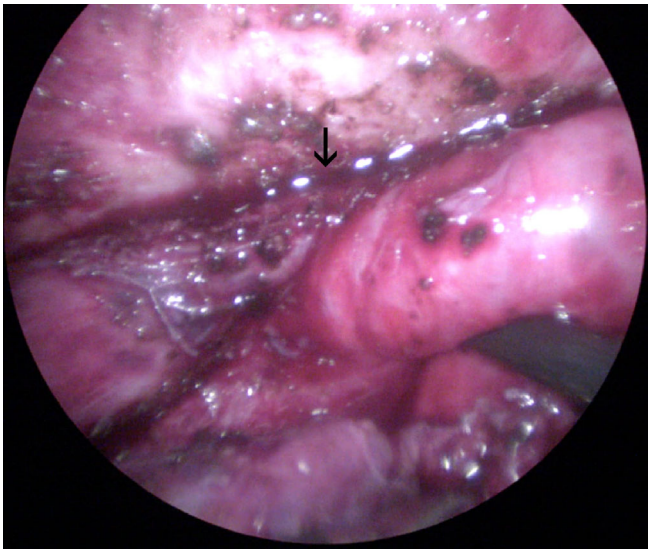

**FIGURE 3** Esophageal stricture (arrow) at level of the anastomosis

## 4 | DISCUSSION

Although the survival rate of patients with EA exceeds 90%, complications after the primary repair can significantly increase morbidity.[1] Esophageal stricture, anastomotic leakage, and recurrent TEF are well-known complications after EA repair. Previous studies found the esophageal stricture rate to vary between 25% and 42%, the anastomotic leakage rate between 11% and 23%, and the recurrent TEF rate between 4% and 9%.[2,3] In a recent meta-analysis, a comparison of thoracoscopic and open approaches found that the thoracoscopic approach notably reduced the length of hospital stay and time to oral refeeding, but it was associated with a longer operative time. The rate of postoperative complications, such as leaks and strictures, was similar between both approaches.[4] Regardless, minimally invasive EA repair remains challenging, and advanced skills are needed to perform the operation successfully. In addition, a considerable learning curve exists, resulting in better outcomes after 5 years of experience.[1]

The main risk factors for anastomotic dehiscence are high tension on the suture, devascularization secondary to extensive dissection, a narrow lower segment, and inadequate mucosal approximation.[5] If a drainage tube is placed during surgery, anastomotic leakage is suspected when esophageal contents drain from the tube. Contrast studies are useful to confirm dehiscences and quantify the leak.[6] Anastomotic leakage is associated with refractory stricture formation and mortality in patients with EA.[5] It has been suggested that dehiscence enhances inflammation and scarring of the anastomosis.[5] There is controversy regarding the definition of minor and major leaks, as well as the appropriate treatment strategy, and these differences limit comparisons between studies.

Complete disruption of the anastomosis requires a surgical intervention such as esophagoesophagostomy or esophageal replacement,[3] whereas a conservative wait-and-see approach is usually employed with minor leaks.[5,6] Although there was no massive contrast leakage in our patients, we decided to perform early reoperations to avoid complications such as pneumothorax, esophageal tissue damage, mediastinitis, and esophageal stricture. Surprisingly, it was possible to redo a partial anastomosis without putting tension on viable esophageal tissues, and none of the patients developed anastomotic strictures. The early surgical repair of dehiscences may be able to prevent anastomotic stenosis, which can lead to dilations under general anesthesia, longer hospital stay, higher costs, and other complications. Therefore, we think that these results could provide an alternative to the conservative treatment of dehiscences. Additionally, it is important to highlight that thoracoscopic approach enables better drainage of the thoracic cavity, which may prevent complications, such as pneumonia or pleurisy, in cases of dehiscence.

Several different risk factors for anastomotic stricture have been proposed. The most important seems to be the tension placed on the anastomosis. Generally, the longer the distance between esophageal pouches, the higher the tension on the anastomosis.[7] The mainstay of anastomotic stricture management is esophageal dilatation. However, its success rate is uncertain, and many different procedures have been developed to treat this complication.[7] There is no consensus on the duration and interval between dilatations. In our department, dilatations are performed when symptoms are present. When endoscopic procedures fail, surgical interventions are indicated. In previous studies, esophageal replacement procedures and esophagectomy with gastric pull-up were performed using either open surgery or minimally invasive surgery.[7,8] However, the first choice should be to conserve the native esophagus.[9] Therefore, in the present cases, we performed a stricture resection and re-anastomosis by thoracoscopic approach. The esophagus had significantly grown in size after earlier thoracoscopy, and we were able to perform an end-to-end anastomosis without tension.

Endoscopic techniques for the treatment of recurrent TEF have emerged as the minimally invasive alternative to the standard open closure. It is an attractive option to many surgeons because it is technically less demanding and takes less time.[10,11] There are different options to close TEF endoscopically: injection of sealants; de-epithelialization with a laser, electrocautery, or trichloroacetic acid[10]; and a combination of both procedures.[11] The main advantages of endoscopic treatments are that they reduce operative time, time to enteral feeding, and length of hospital stay. However, these treatments usually require several sessions under general anesthesia, and they are not exempt from complications.[12] The failure of the closure increases the anxiety of the family and the risk of feed aspiration, which may lead to chronic respiratory disease.

Several open surgical procedures have been described in the treatment of TEF closure. Most authors close recurrent

TEF by lateral thoracotomy or cervicotomy. Tissue interposition between trachea and esophagus has been added to avoid postoperative leaks and recurrences.[13] In 2017, Rothenberg reported the first successful thoracoscopic closure of congenital TEF using a 5-mm endoscopic stapler.[14] We decided to combine a mechanical closure of the TEF with a pleural flap between the trachea and the esophagus in order to avoid recurrence as much as possible. In addition to the well-known benefits of the thoracoscopic approach, this technique had significant advantages: (a) mechanical sutures were faster and safer, (b) no chest drain was necessary, (c) the patient could be extubated immediately after surgery, and (d) enteral feeding began on the morning after surgery.

In conclusion, reoperation after esophageal atresia repair is challenging and carries a relatively high risk of developing complications. The formation of scars and adhesions is the norm after initial repair. However, these fibrous tissues may interfere with the dissection, possibly resulting in damage to the esophagus and trachea. The thoracoscopic approach offers better visualization and more accurate dissection in experienced hands than conventional surgery. Therefore, we want to encourage the use of thoracoscopy for the treatment of complications after EA repair.

## AUTHOR CONTRIBUTIONS

Study design: B. Aneiros, I. Cano, and J. Goody
Data generation: I. Cano, J. Godoy, and A. García
Data gathering: A. García, M. C. Puentes, and C. Moreno
Data analysis: B. Aneiros, J. Godoy, M. C. Puentes and C. Moreno
Drafted manuscript: I. Cano, B. Aneiros, and A. García
All the authors approved the final version of this paper and are in agreement with its content.

## CONFLICT OF INTEREST

The authors have no potential conflicts of interest to disclose.

## ORCID

*Belén Aneiros Castro* https://orcid.org/0000-0001-6130-8816

## REFERENCES

1. Dingemann C, Ure BM. Minimally invasive repair of esophageal atresia: an update. *Eur J Pediatr Surg*. 2013;23(3):198-203.
2. Zimmer J, Eaton S, Murchison LE, Ure BM, Dingemann C. State of play: eight decades of surgery for esophageal atresia. *Eur J Pediatr Surg*. 2018;29(1):39-48. https://doi.org/10.1055/s-0038-1668150.
3. Lal DR, Gadepalli SK, Downard CD, et al. Perioperative management and outcomes of esophageal atresia and tracheoesophageal fistula. *J Pediatr Surg*. 2017;52(8):1245-1251.
4. Wu Y, Kuang H, Lv T, Wu C. Comparison of clinical outcomes between open and thoracoscopic repair for esophageal atresia with tracheoesophageal fistula: a systematic review and meta-analysis. *Pediatr Surg Int*. 2017;33(11):1147-1157.
5. Bawa M, Menon P, Mahajan JK, Peters NJ, Garge S, Rao KL. Role of feeding jejunostomy in major anastomotic disruptions in esophageal atresia: a pilot study. *J Indian Assoc Pediatr Surg*. 2016;21(1):24-27.
6. Morini F, Conforti A, Bagolan P. Perioperative complication of esophageal atresia. *Eur J Pediatr Surg*. 2018;28(2):133-140.
7. Baird R, Laberge JM, Lévesgue D. Anastomotic stricture after esophageal atresia repair: a critical review of recent literature. *Eur J Pediatr Surg*. 2013;23(3):204-213.
8. Castle SL, Isani M, Torres MB, Anselmo DM, Nguyen NX. Tubularized gastric conduit is more desirable in pediatric patients treated with minimally invasive esophagectomy and gastric pull-up. *J Laparoendosc Adv Surg Tech A*. 2017;27(4):427-429.
9. Zani A, Cobellis G, Wolinska J, Chiu PP, Pierro A. Preservation of native esophagus in infants with pure esophageal atresia has good long-term outcomes despite significant postoperative morbidity. *Pediatr Surg Int*. 2016;32(2):113-117.
10. Lelonge Y, Varlet F, Varela P, et al. Chemocauterization with trichloroacetic acid in congenital and recurrent tracheoesophageal fistula: a minimally invasive treatment. *Surg Endosc*. 2016;30(4):1662-1666.
11. Nazir Z, Khan MAM, Qamar J. Recurrent and acquired tracheoesophageal fistulae (TEF) – minimally invasive management. *J Pediatr Surg*. 2017;52(10):1688-1690.
12. Aworanti O, Awadalla S. Management of recurrent tracheoesophageal fistulas: a systematic review. *Eur J Pediatr Surg*. 2014;24(5):365-367.
13. Wang J, Zhang M, Pan W, Wu W, Yan W, Cai W. Management of recurrent tracheoesophageal fistula after esophageal atresia and follow-up. *Dis Esophagus*. 2017;30(9):1-8.
14. Rothenberg SS. Thoracoscopic management of non-type C esophageal atresia and tracheoesophageal atresia. *J Pediatr Surg*. 2017; pii: S0022-3468(17)30647-4. https://doi.org/10.1016/j.jpedsurg.2017.10.025

**How to cite this article:** Cano Novillo I, Aneiros Castro B, Godoy Lenz J, Puentes Rivera MC, García Vázquez A, Moreno Zegarra C. Thoracoscopic approach for complications after esophageal atresia repair: initial experience. *Asian J Endosc Surg*. 2020; 13:147–151. https://doi.org/10.1111/ases.12714