Esophageal Atresia: Postoperative Complications and Involved Factors

Davoud Badebarin[1], Saied Aslanabadi[1], Reza Aghaie[1], Ibrahim Farhadi[1], Dara Rahmanpour[1]

[1] Department of Pediatric Surgery, Tabriz University of Medical Sciences, Tabriz, Iran

***Address for Corresponder:** Dr Davoud Badebarin, Department of Pediatric Surgery, Tabriz University of Medical Sciences, Tabriz, Iran (email: dbadebarin@gmail.com)

How to cite this article:
Badebarin D, Aslanabadi S**,** Aghaie R**.** Esophageal Atresia: Postoperative Complications and Involved Factors. Iranian Journal of Pediatric Surgery 2024; 10 (1):13 - 26.

DOI: https://doi.org/10.22037/irjps.v10i1.44233

Abstract

Introduction: Esophageal atresia (EA) is a relatively common congenital anomaly. Following the increase in the survival rate of neonates with appropriate surgical procedures, timely diagnosis and treatment of surgical complications are essential.

Materials and Methods: After getting ethical approval, all the patients who underwent surgery for EA at Tabriz Children's Hospital were contacted, and in case of any long-term complications, parents were invited to visit the hospital.

Results: Fifty-five children, including 31 boys and 24 girls, with a mean birth weight of 2734.63±566.21 grams and an APGAR score of 8.75±0.96, participated in this study. The most common type of EA was type C (87.3%). Respiratory disorders (47.3%) and marked anastomotic stenosis (21.8%) are the most common complications following surgery. Anastomotic stenosis was associated with suture tension, tracheal intubation >5 days, and birth weight<2,500 grams.

received: 30 December 2023
accepted: 17 February 2024
Published online: 14 April 2024

Keywords

- Esophageal atresia
- Surgery
- pediatrics

Conclusion: In the postoperative phase of EA surgery, respiratory disorders are a common complication. Anastomotic stenosis is the second most common complication. It is associated with suture tension, tracheal intubation for more than five days, birth weight less than 2,500 grams, Gastroesophageal reflux into the esophagus, and leakage from anastomosis. There is a need for future multi-center studies to provide more reliable evidence.

Introduction

Congenital esophageal atresia (EA) with tracheoesophageal fistula (TEF) is a relatively common anomaly, with a prevalence of one in every 3,500 live births .[1-5] There are four types of esophageal atresia: Type A, B, C, and D.

Since the first successful surgery in 1941, the treatment of these patients has improved considerably in terms of anesthesia, surgery, and neonatal care.[6] The long-term survival rate of patients undergoing this approach in the absence of other malformations is 100%.[7-9] Most patients underwent surgery after birth in the first days of life by pediatric surgeons. In the most common type of esophageal atresia, the C type, the upper and lower pouches are joined after the fistula from the airway is cut, and its wall is closed.[10-11] The reported survival rates among patients with low birth weight have been documented to exceed 90%. It is worth noting that cardiac anomalies represent a significant contributor to mortality in this population.[12] EA/TEF is a multifaceted anomaly, ranging from isolated atresia without TEF to EA with multiple airway fistulas or cases with secondary complex anatomy referred to previous treatments.[13] Following this increase in survival, the morbidity related to the repair of EA/TEF has become a principal topic in treating these children.[14-15] Clinical experiences vary in outcome after EA/TEF treatment. Some patients have uncomplicated postoperative periods, and others have experienced numerous respiratory and

esophageal complications that significantly affect their health status.[16-17]

Postoperative complications in these patients have been defined in different ways. Some studies have divided short-term complications up to the first year of life.[17] These complications include gastroesophageal reflux, esophageal stricture, chronic dysphagia, recurrent fistula, pulmonary infections, asthma, and tracheomalacia.[18-19] Also, long-term complications such as Barrett's esophagus, esophageal carcinoma, and scoliosis have been reported.[20-21] Although the nature of these complications is well understood, their occurrence, association, and progression during the first year of life remain unknown.[22]

Long-term complications after surgery are an essential issue in assessing these children's condition. Since the occurrence of these complications is relatively common, the purpose of this study on patients with EA is to diagnose the complications and the time of their occurrence and treat those using surgical or medical methods.

Materials and Methods

This study was conducted after obtaining ethical approval from the ethics committee of Tabriz University of Medical Sciences (IR.TBZMED.REC.1398.1059). Informed written consent was also obtained from all the participants before their inclusion in the study. The census sampling approach was used to include 55 children with EA congenital abnormalities referred to the Tabriz Children's Hospital for surgery between April 2016 and March 2018.

All patients who underwent surgery for EA (with or without tracheoesophageal fistula) at Tabriz Children's Hospital were contacted by telephone. Parents were invited to visit the hospital if there were any complaints about long-term complications of the surgery, including anastomotic stenosis, recurrent fistulas, and reflux of gastric contents into the esophagus, lung disease, and thoracotomy-related problems. After obtaining informed consent, a complete history and examinations were done, a questionnaire was made, which includes demographic information, birth information, type of atresia, and type of complications. Then the necessary therapeutic interventions,

whether surgery or drug treatment, began. In case of hospitalization, six months after discharge, patients were contacted about the continuation of the previous complaint or the occurrence of a new complaint. If there was a complaint, an invitation was made to re-visit and make the necessary inquiries.

The data were analyzed using SPSS version 22. Descriptive statistical methods (frequency, percentage, and mean standard deviation) were used for statistical analysis. A Chi-square test was used to compare qualitative findings. A one-way ANOVA, non-parametric Kruskal-Wallis test, and independent t-test were used to compare the quantitative findings. A P-value<0.05 was considered significant in this study. To remove the effects of confounders, logistic regression analysis was also conducted.

Result

This study included 55 children with EA, 31 (56.4%) boys and 24 (43.6%) girls aged 1 - 5 days. There was a history of consanguineous marriage in 4 patients (7.3%). The most common type of EA was group C (87.3%), followed by type A (7.3%), type B (3.6%), and Type D (1.8%). **Table 1** shows the characteristics of the participants. A total 38 children (69.1%) were born full-term and 17 (30.9%) were born preterm. In preterm cases, the mean age at birth was 33.94 ± 2.83 weeks (between 26 and 37 weeks). Also 17 patients (30.9%) had no congenital anomalies at birth. The most common congenital anomaly in patients with EA was cardiac anomalies (49.1%).

Table 1: Characteristics of patients involved in the study.

Characteristics	Frequency or mean ± SD	Min and max
Birth weight (g)	2734.63 ± 566.21	4000-1500
Familial Birth defect	1.86 ± 0.85	1-4
APGAR score	8.75 ± 0.96	5-10
History of abortion	5 (9.1%)	-
tracheoesophageal fistula	48 (87.3%)	-
Cardiac Anomalies	27 (1/49%)	
ASD	24 (43.6%)	
VSD	5 (9.1%)	
PDA	20 (11%)	
CDH	1 (1.8%)	
Dextrocardia	1 (1.8%)	
Horseshoe kidney	2 (3.6%)	
imperforate Anus	5 (9.1%)	
Musculoskeletal Anomalies	12 (21.8%)	
Syndactyly	2 (3.6%)	
Vertebral Anomaly	5 (9.1%)	
Costal Anomaly	5 (9.1%)	
Hand Deformity	3 (5.5%)	
Foot Deformity	1 (1.8%)	
ENT Anomalies	2 (3.6%)	
Choanal atresia	1 (1.8%)	
Cleft palate	1 (1.8%)	
Ear Deformity	1 (1.8%)	

Complications in patients are shown in **Table 2**.

Table 2: Frequency of complications in patients after surgery

complications	Frequency
stenosis of the anastomosis site	12 (21.8%)
Tension on suture site	11 (20%)
recurrent fistulas	5 (9.1%)
Gastroesophageal reflux into esophagus	9 (16.4%)
Respiratory disorders following surgery	26 (47.3%)
Post-surgery pulmonary problems	5 (9.1%)

Finally, 49 patients (89.1%) developed one of the complications during the follow-up period. The most common complications in patients were respiratory disorders following surgery (47.3%), anastomotic stenosis (21.8%), and gastroesophageal reflux (16.4%), respectively.

A total of 23 children were treated for complications. The types of treatment were dilation (18.2% of all cases), surgery (9.1% of all cases), or medicines (14.5% of all cases). The success rate of drug treatments for reflux and dilatation for stenosis was 88.8%. After surgery, 16 children (25%) required intubation for more than five days. The survival rate of neonates with EA who underwent surgery was 97%. There was no significant relationship between anastomotic site stenosis and gastroesophageal reflux, cardia anomalies, age at birth (term or preterm), and TEF ($P>0.05$); however, in patients with tension at the suture site, the incidence of anastomotic site stenosis was significantly higher ($P <0.05$). Also, the incidence of anastomotic site stenosis was significantly higher in patients who had leakage ($P = 0.001$). There was no significant

relationship between the age of preterm children at birth, birth weight and Apgar score with stenosis of the anastomosis site **(Table 3)** (P >0.05).

Table 3: Relationship between anastomotic stenosis and the studied variable

Characteristics	Anastomotic site stenosis (N=12)	No Anastomotic site stenosis (N=43)	p-value
Birth weight (g)	2916.96 ± 578.25	2749.25 ± 551.13	0.27
Birth weight > 2500	3 (10.3%)	26 (89.7%)	0.03*
Birth age (for preterm children)	35.14 ± 1.57	33.10 ± 3.28	0.15
APGAR score	8.88 ± 0.71	8.61 ± 1.16	0.32
Suture traction	9 (81.8%)	2 (19.2%)	0.001*
Gastroesophageal reflux into esophagus	5 (55.6%)	4 (44.4%)	0.01*
leakage from anastomosis	5 (100%)	0 (0%)	0.001*
Preterm birth	17 (63%)	10 (37%)	0.25
tracheoesophageal fistula	23 (82.1%)	5 (17.9%)	0.22
Intubation for 5+ days	7 (58.3%)	5 (41.7%)	0.002*

The incidence of anastomotic stenosis in children weighing less than 2500 grams at birth was significantly higher (P = 0.03). Also, the incidence of anastomotic stenosis as the most important complication in neonates with intubation for more than five days was significantly higher (P = 0.002). This study showed that one of the most important causes of complications, especially stenosis at the anastomosis site, were the sutures being stretched at the anastomosis site.

Based on the logistic regression analysis, the presence of tension in the sutures and leakage significantly predicts the occurrence of anastomotic site stenosis (P <0.05). Also, tracheal intubation for more than five days and a weight of less than 2500 grams significantly increases the stenosis of the anastomosis site **(Table 4).**

Table 4: Logistic regression test for predicting variables predicting anastomotic site stenosis

Characteristics	Beta	T	p-value
Birth weight (g)	0.24	2.32	0.001*
Tension on suture site	0.72	7.69	0.001*
Intubation for 5+ days	0.28	3.08	0.024*
leakage from anastomosis	0.41	4.94	0.001*

Discussion

Based on our assessment, the most common congenital anomaly in patients with EA was a cardiac anomaly (49.1%) and the most common complications in patients were respiratory problems following surgery (47.3%), anastomotic stenosis (21.8%), and gastroesophageal reflux disease (16.4%), respectively. Anastomotic stenosis was also found to be more likely when there was tension in the sutures, the patient had been intubated for longer than five days, and their weight was less than 2500 grams. Patients with anastomotic stenosis were more likely to experience leakage at the anastomotic site and had a higher rate of reflux. These factors can be used as predictors of complications, especially stenosis of the anastomosis site, and if any of the above factors occur, the risk of complications increases.

Mutations of a single gene, like those that cause CHARGE syndrome, Feingold syndrome, Fanconi anemia, and VACTERL-H, as well as chromosome abnormalities like trisomy 21, trisomy 18, trisomy 13, and the X gene, can cause TE. For the establishment of a specific genetic cause, taking a history, a physical examination, a three-generation family history, imaging studies, and cytogenic and molecular genetic assessments can be helpful.[5] Further genomic analysis for appropriate identifications of novel candidate genes will likely help us recognize previously unknown causes.[23]

Contrary to the results of the present study, Nateghian et al.[24] described gastrointestinal anomalies (20%) as the most common accompanying anomalies, which may be due to higher rates of consanguineous marriages in the northwest of the country. According to the results of the present study, the most common complications after EA surgery were anastomotic stenosis (21.8%), reflux (16.4%), and respiratory disorders following surgery (47.3%). Serhal and colleagues obtained different results from the present study, in which the most common complication was anastomotic stenosis, but its incidence was higher, and its frequency was 37%.[25] Because of the high prevalence of acid gastroesophageal reflux, systematic treatment with proton pump inhibitors in the first year of life is recommended for these patients.[26]

An increased incidence of anastomotic stenosis was also reported by Cartabuke et

al.[27] and Koziarkiewicz et al.[28] In line with the present study, Nateghian et al. reported that the most common complications after EA surgery are anastomotic stenosis, reflux, lung collapse, and various types of pneumonia.[24]

Our study showed that the presence of tension in the sutures, intubation for more than five days, and a weight less than 2500 g increases the risk of stenosis at the anastomosis site. In line with the above study, Castilloux et al. also reported that tracheal intubation for more than five days, VACTRAL abnormalities, and birth weight less than 2500 g are significantly involved in complications after EA surgery.[17] Serhal et al. presented similar results regarding the role of anastomotic stress in the development of anastomotic stenosis.[25]

In the present study, about 29.09% of patients eventually needed medical treatment, surgery, or combination therapy to treat complications, of which 88.8% were under drug treatment for reflux and 83.3% were under surgical treatment for stenosis (balloon dilatation or revision of anastomosis). According to the results of the study of Serhal et al., dilatation treatment for stenosis was about 87% effective, which is consistent with the results of our study.[25]

A recent systematic review compared thoracotomy and thoracoscopy for the repair of esophageal atresia. This study found no statistically significant differences in anastomotic leak rates, formation of esophageal strictures following anastomoses, or need for fundoplication which suggested similar morbidity for thoracoscopic and open approaches.[32] In terms of outcomes, another meta-analysis found the length of hospital stay and first oral feeding time for the thoracoscopic approach, while open surgery was associated with a shorter operative time.[33]

The tracheomalacia at the site of the fistula is the main abnormality that causes airway collapse and impaired clearance of secretions. Flexible bronchoscopy, aided by imaging modalities, is suggested as the main diagnostic modality in this regard. Noninvasive positive airway pressure support, tracheopexy, and rarely tracheostomy, with appropriate follow-up are management plans that should be done in patients.[29-31]

Due to the desire of surgeons in other countries to use thoracoscopy for EA

surgery in recent years (34), it is recommended to use the above method to treat EA and compare the complications between open and thoracoscopic methods.

Conclusion

The results of the present study showed that the most common complication after EA surgery was respiratory problems caused by surgery followed by anastomotic stenosis. Risk factors for anastomotic stenosis are suture tension, tracheal intubation for more than five days, and a birth weight of less than 2,500 grams. Due to some differences between the results of this study and other similar studies, it is suggested that more multi-center studies be performed to obtain more accurate results.

Ethical Consideration

This study was approved by the research ethics committee of Tabriz University of Medical Sciences (IR.TBZMED.REC.1399.1059) and the Committee for Ethics of Medical Experiments on Human Subjects and was conducted in accordance with the principles of the Declaration of Helsinki.

Acknowledgment

We would like to thank the clinical research development unit of children educational research and treatment center, Tabriz University of medical sciences for their supports.

Funding/Support

Not applicable

Conflict of interests

There is no conflict of interest

References

1. Shaw-Smith C: Oesophageal atresia, tracheo-oesophageal fistula, and the VACTERL association: review of genetics and epidemiology. Journal of medical genetics. 2006 Jul 1;43(7):545-54.

2. Dingemann C, Eaton S, Aksnes G, et al: ERNICA Consensus Conference on the Management of Patients with Esophageal Atresia and Tracheoesophageal Fistula: Follow-up and Framework. Eur J Pediatr Surg. 2020;30(06):475-82.

3. Intissar C, Faouzi N, Yosra BA, et al: Esophageal atresia with tracheoesophageal fistula: A novel rare variant. Journal of Pediatric Surgery Case Reports. 2021 Jan 1; 64:101691.

4. Bence CM, Lal DR: Esophageal Atresia With or Without Tracheoesophageal Fistula. Pearls and Tricks in Pediatric Surgery. 2021:35-40.

5. Scott DA: Esophageal Atresia / Tracheoesophageal Fistula Overview. 2009 Mar 12 [Updated 2018 Sep 20]. In: Adam MP, Ardinger HH, Pagon RA, et al., editors. GeneReviews® [Internet]. Seattle (WA): University of Washington, Seattle; 1993-2021.

6. Nakayama DK: The history of surgery for esophageal atresia. Journal of Pediatric Surgery. 2020 Jul 1;55(7):1414-9.

7. Lopez PJ, Keys C, Pierro A, et al: Oesophageal atresia: improved outcome in high-risk groups? Journal of pediatric surgery. 2006;41(2):331-4.

8. Alfaro L, Bermas H, Fenoglio M, et al: Are patients who have had a tracheoesophageal fistula repair during infancy at risk for esophageal adenocarcinoma during adulthood? Journal of pediatric surgery. 2005;40(4):719-20.

9. Smink DS. Schwartz's principles of surgery. LWW; 2015.

10. Sinha C, Haider N, Marri R, Rajimwale A, Fisher R, Nour S. Modified prognostic criteria for oesophageal atresia and tracheo-oesophageal fistula. European journal of pediatric surgery. 2007;17(03):153-7.

11. Iacona RV, Saxena AK: Thoracoscopic repair of esophageal atresia with distal tracheoesophageal fistula (Type C): systematic review. Surgical Laparoscopy Endoscopy & Percutaneous Techniques. 2020;30(4):388-93.

12. Burford JM, Dassinger MS, Copeland DR, et al: Repair of esophageal atresia with tracheoesophageal fistula via thoracotomy: a contemporary series. The American journal of surgery. 2011;202(2):203-6.

13. Friedmacher F, Kroneis B, Huber-Zeyringer A, et al: Postoperative complications and functional outcome after esophageal atresia repair: results from longitudinal single-center follow-up. Journal of Gastrointestinal Surgery. 2017;21(6):927-35.

14. Deurloo JA, Ekkelkamp S, Schoorl M, et al: Esophageal atresia: historical evolution of management and results in 371 patients. The Annals of thoracic surgery. 2002;73(1):267-72.

15. Taylor AC, Breen KJ, Auldist A, et al: Gastroesophageal reflux and related pathology in adults who were born with esophageal atresia: a long-term follow-up study. Clinical Gastroenterology and Hepatology. 2007;5(6):702-6.

16. Kovesi T, Rubin S: Long-term complications of congenital esophageal atresia and/or tracheoesophageal fistula. Chest. 2004;126(3):915-25.

17. Castilloux J, Noble AJ, Faure C: Risk factors for short-and long-term morbidity in children with esophageal atresia. The Journal of pediatrics. 2010;156(5):755-60.

18. Deurloo JA, Ekkelkamp S, Taminiau JA, et al: Esophagitis and Barrett esophagus after correction of esophageal atresia. Journal of pediatric surgery. 2005;40(8):1227-31.

19. Koivusalo A, Pakarinen M, Rintala R, et al: Does postoperative pH monitoring predict complicated gastroesophageal reflux in patients with esophageal atresia? Pediatric surgery international. 2004;20(9):670-4.

20. Yanchar N, Gordon R, Cooper M, et al: Significance of the clinical course and early upper gastrointestinal studies in predicting complications associated with repair of esophageal atresia. Journal of pediatric surgery. 2001;36(5):815-22.

21. Bjornson CL, Mitchell I: Congenital tracheoesophageal fistula and coordination of care: expectations and realities. Paediatrics & child health. 2006;11(7):395-9.

22. Little D, Rescorla F, Grosfeld J, et al: Long-term analysis of children with esophageal atresia and tracheoesophageal fistula. Journal of pediatric surgery. 2003;38(6):852-6.

23. Wang J, Ahimaz PR, Hashemifar S, et al: Novel candidate genes in esophageal atresia/tracheoesophageal fistula identified by exome sequencing. European Journal of Human Genetics. 2021;29(1):122-30.

24. Nateghian A, Delshad S, Nasiri SJ, et al: Investigating respiratory complications and anomalies after esophageal atresia treatment in Aliasghar Hospital in Tehran during 1995-2009. Razi Journal of Medical Sciences. 2014;21(123):75-82.

25. Serhal L, Gottrand F, Sfeir R, et al: Anastomotic stricture after surgical repair of esophageal atresia: frequency, risk factors, and efficacy of esophageal bougie dilatations. Journal of pediatric surgery. 2010;45(7):1459-62.

26. Flatrès C, Aumar M, Ley D, et al: Prevalence of acid gastroesophageal reflux disease in infants with esophageal atresia/tracheoesophageal fistula. Pediatric Research. 2021.

27. Cartabuke RH, Lopez R, Thota PN: Long-term esophageal and respiratory outcomes in children with esophageal atresia and tracheoesophageal fistula. Gastroenterology report. 2016;4(4):310-4.

28. Koziarkiewicz M, Taczalska A, Jasinska-Jaskula I, et al: Long-term complications of congenital esophageal atresia–single institution experience. Indian pediatrics. 2015;52(6):499-501.

29. Koumbourlis AC, Belessis Y, Cataletto M, et al: Care recommendations for the respiratory complications of esophageal atresia-tracheoesophageal fistula. Pediatric Pulmonology. 2020;55(10):2713-29.

30. Lee S, Meeker TM: Basic knowledge of tracheoesophageal fistula and esophageal atresia. Advances in Neonatal Care. 2018;18(1):14-21.

31. Porcaro F, Valfré L, Aufiero LR, et al: Respiratory problems in children with esophageal atresia and tracheoesophageal fistula. Italian Journal of Pediatrics. 2017;43(1):77.

32. Way C, Wayne C, Grandpierre V, et al: Thoracoscopy vs. thoracotomy for the repair of esophageal atresia and tracheoesophageal fistula: a systematic review and meta-analysis. Pediatric Surgery International. 2019;35(11):1167-84.

33. Wu Y, Kuang H, Lv T, et al: Comparison of clinical outcomes between open and thoracoscopic repair for esophageal atresia with tracheoesophageal fistula: a systematic review and meta-analysis. Pediatric Surgery International. 2017;33(11):1147-57.

34. Etchill EW, Giuliano KA, Boss EF, et al: Association of operative approach with outcomes in neonates with esophageal atresia and tracheoesophageal fistula. Journal of Pediatric Surgery. 2021.