


Preservation of Azygos vein in primary repair of esophageal atresia: Nine cases' experience

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ABSTRACT

Objective: Studies on preserving the Azygos vein (AV) in primary esophageal atresia (EA) repair and its effects on complications such as stenosis, anastomotic leakage, and fistula are gradually increasing. We aimed to evaluate cases with preserved AV during primary repair of EA with thoracotomy.

Material and Methods: The demographic data, operation notes, and postoperative outcomes of primary EA repair cases with preserved AVs operated between 2016 and 2021 were evaluated from hospital records, retrospectively.

Results: In 5 years, the AVs of 9 neonates with esophageal atresia + distal fistula were preserved in 6 males and 3 females. The mean birth weight was 2374 g. Four cases were preterm. Echocardiography revealed an Interatrial Septal Aneurysm in 1, Fallot's Tetralogy in 1, and a right aortic arch in 1 patient. The mean age at surgery was 4 days (1–8 days); all patients were operated through a right thoracodorsal incision by the same surgeon. Extra-pleural thoracotomies were completed as intrapleural in four patients. The oblique-oblique anastomosis was tension-free in all cases. Enteral feeding began on the 4th day by nasogastric tube. The median duration of intubation was 6.6 days (1–11 days). Chest tubes were removed on the 10th day (8–14th day). No patient had anastomotic leakage, detachment, or fistula recurrence. The median hospitalization duration was 23.2 days (10–32 days). Four patients underwent esophageal dilation.

Conclusion: Postoperative anastomotic leakage, fistula, and stenosis increase mortality and morbidity in children undergoing EA repair. During primary repair, the preservation of AV, which significantly contributes to esophageal drainage, should be preferred unless it increases intraoperative risk.

Keywords: Azygos vein, esophageal atresia, neonate, tracheoesophageal fistula.

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INTRODUCTION

Esophageal atresia (EA) is a congenital anomaly with high morbidity and mortality rates. Since the first report of EA in 1670 and the first survival following primary anastomosis in 1940, survival rates of cases with EA have significantly improved.^[1,2] Improvements in pre- and postoperative care have contributed to favorable outcomes in most cases. Many surgical methods for EA repair have been developed, and the surgical technique of EA repair was advanced especially by the use of the thoracoscopic approach.^[3]

Dividing the Azygos vein is a classic step both in thoracotomy and thoracoscopy during the repair of EA. The Azygos vein receives blood from vessels draining the esophagus; hence, it was suggested to preserve the Azygos vein during the operation to reduce early anastomotic edema.^[4] Since this first suggestion in 2007, studies about preserving the Azygos vein in primary EA repair and its effects on complications such as anastomotic leakage, stenosis, fistula, and respiratory problems seem to be increasing gradually.

In our pediatric surgery department, preserving the Azygos vein, if possible, during the operation has been preferred since 2016. In this study, it was aimed to evaluate the clinical effects of Azygos vein preservation during the operation for primary esophageal repair of neonates with EA.

MATERIAL AND METHODS

In this retrospective study, patients who underwent repair of EA/tracheo-esophageal fistula with preserved Azygos vein within a 5-year period (between January 2016 and 2021) were reviewed. The study was approved by the Hospital Ethics Committee under the number 2020-141 and was conducted in accordance with the Declaration of Helsinki. All patients who underwent primary repair of EA with thoracotomy between 2016 and 2021 were retrospectively reviewed from hospital records, and all neonates whose Azygos veins were preserved during the primary repair of EA were enrolled.

Patients were evaluated in terms of demographic data, associated anomalies, upper pouch level, distal fistula diameter, anastomosis type and tension, duration of hospitalization, postoperative conditions, and complications such as anastomotic leakage, stenosis, recurrent fistula, and the need for reoperation.

Anastomotic leakage was diagnosed by either saliva drainage from the chest tube or leak from anastomosis in upper GI contrast studies. Patients with anastomotic stenosis underwent esophageal dilation with Savary-Gilliard dilators under rigid endoscopy.

RESULTS

Over the past five years, the Azygos veins (AVs) of 9 neonates with esophageal atresia + distal fistula were preserved in 6 males (66.6%) and 3 females (33.3%), accounting for 30% of the cases. One case was found to have Azygos vein agenesis intraoperatively and was excluded from the study. The mean birth weight of the patients was 2374 g (range: 1370–3600 g). Four patients were preterm, with gestational ages of 23 weeks + 2 days, 32 weeks +

5 days, 34 weeks + 2 days, and 36 weeks; the remaining 5 were term. One patient was diagnosed with severe hydrocephalus in utero, and another had an imperforate anus. Polyhydramnios was present in the pregnancies of three patients.

Postnatal echocardiography revealed Patent Foramen Ovale in 7 patients, Fallot's Tetralogy in 1, interatrial septal aneurysm in 1, and a right aortic arch in 1 patient. The mean age at surgery was 4 days (range: 1–8 days); all patients underwent surgery through a right thoracodorsal incision by the same surgeon. Although all thoracotomies began as extra-pleural, they were completed as intra-pleural in four patients. The median level of the upper pouch was at the 2nd vertebra (range: 1st–3rd vertebra), the median level of the fistula was at the 3rd vertebra (range: 2nd–4th vertebra), and the median gap length between the esophageal ends was 1.4 cm (range: 1–3 cm). The median diameter of the fistula was 5.5 mm (range: 3–9 mm). The oblique-oblique anastomosis between the esophageal ends was completed without anastomotic tension in all cases. The median number of stitches used for anastomosis was 9.5 stitches (range: 3–12 stitches) in all cases except one; in the baby with severe hydrocephaly, the anastomosis of the esophageal ends was completed with only 3 separated stitches. This patient was a very low birth weight (VLBW) preterm (23 weeks + 2 days) and experienced frequent desaturation during the operation, with bradycardia developing during fistula ligation. The heart rate barely increased to around 90 beats per minute after administering adrenaline intravenously; therefore, after the anastomosis of the esophageal ends, the incision was closed immediately. Demographic data and findings from the operations are summarized in Table 1.

The median feeding time by nasogastric tube was the 4th day (2nd–7th day) postoperatively. The median oral feeding time was 19.6 days (8–41 days) postoperatively in 8 patients. The median removal time of the thorax tubes was the 10th postoperative day (8th–14th postoperative day) after seeing no leakage on contrast studies. The median duration of postoperative intubation was 6.6 days (1–11 days) among 8 patients. One patient which had hydrocephaly was transferred to another neonatal intensive care unit while intubated on the 15th postoperative day. This case had been fed fully by NGT without any anastomotic leakage, stenosis or fistula recurrence in the contrast study of the esophagus. The median hospitalization of the other 8 patients was 23.2 days (10–32 days); only one case who had severe Fallot Tetralogy, was discharged with a nasogastric feeding tube due to insufficient oral feeding, while seven were discharged feeding orally.

The median follow-up period was 45 months (25 months–6.5 years). After discharge one patient was diagnosed with cystic fibrosis and another with central hypothyroidism. One patient underwent bronchoscopy due to recurrent pneumonia but no recurrent fistula was seen. No patients had anastomotic leakage, dehiscence, stenosis, fistula recurrence or wound detachment. Four patients underwent esophageal dilation, 1 patient once, 2 patients twice and the patient who was fed by nasogastric tube on discharge 5 times. The fistula diameters of these cases requiring esophageal dilatation were 5, 3, 5 and 9 mm respectively. The case with a 9 mm fistula was observed to have the longest gap intraoperatively. Postoperative outcomes of patients were summarized in Table 2.

Table 1: Demographic data and operation findings

	Sex	GA	BW (gr)	MC	AA	OD	LUP (ver)	MG (cm)	LF (ver)	DF (mm)	NS
Patient 1	M	34 w + 2 d	1840	Preeclampsia	PFO	7	2	2	4	5	9
Patient 2	M	41 w	3000	HBV+	PDA, ASD, TR, right aortic arch, cystic fibrosis	5	1	1	2	3	10
Patient 3	M	37 w + 2 d	2015	Polyhydramnios	PFO, PDA, fallot tetralogy	3	3	1	4	5	10
Patient 4	M	38 w	3320	Polyhydramnios	PFO	2	2	3	4	9	9
Patient 5	F	36 w	2440	–	PFO, central hypothyroidism	5	2	2	4	5	11
Patient 6	F	32 w + 5 d	1370	Hypothyroidism	VSD, PFO	4	3	1	4	3	11
Patient 7	M	40 w	3600	HBV+	Imperforate anus, ASD, VSD, interatrial septal aneurysm	1	3	1	4	8	12
Patient 8	M	23 w + 2 d	1380	–	PFO, hydrocephalus	8	2	1	3	8	3
Patient 9	F	38 w + 3 d	2400	Polyhydramnios, preeclampsia	PFO	1	3	1	4	4	11

M: Male; F: Female; HBV: Hepatitis B virus; PFO: Patent foramen ovale; PDA: Patent ductus arteriosus; ASD: Atrial septal defect; TR: Tricuspid regurgitation; VSD: Ventricular septal defect; GA: Gestational age; BW: Birth weight; MC: Maternal conditions; AA: Additional anomalies; OD: Operation day; LUP: Level of upper pouch; Ver: Vertebra; MG: Mean gap; LF: Level of fistula; DF: Diameter of fistula; NS: Number of stitches.

Table 2: Postoperative outcomes

	RTT	R NGT	Feeding	DI (days)	FD	LS (days)	FuP (months)	Pne. (yearly)	Dil.	AD (months)
Patient 1	9	14	4. day by NGT, 13. day orally	1	Oral	22	81	6	–	–
Patient 2	13	13	4. day by NGT, 13. day orally	11	Oral	19	67	3	2	11, 12
Patient 3	14	23	4. day by NGT, 23. day orally	9	Oral	28	61	–	1	8
Patient 4	9	45	5. day by NGT, 41. day orally	8	NGT	28	49	3	5	1.5, 4.5, 5, 6.5, 10
Patient 5	9	13	7. day by NGT, 13. day orally	7	Oral	20	34	2	2	1.5, 3
Patient 6	8	27	2. day by NGT, 27. day orally	5	Oral	32	32	–	–	–
Patient 7	8	8	2. day by NGT, 8. day orally	5	Oral	10	31	–	–	–
Patient 8	11	–	4. day by NGT*	–	NGT	–	30	–	–	–
Patient 9	10	19	4. day by NGT, 19. day orally	7	Oral	27	25	–	–	–

*: This case was feed 5 months later by orally in follows-up; NGT: Nasogastric tube; RTT: Removal of thorax tube; R NGT: Removal of NGT; DI: Duration of intubation; FD: Feeding on discharge; LS: Length of stay; FuP: Follow-up period; Pne: Pneumonia; Dil: Dilatations; AD: Age of dilatations.

DISCUSSION

The classic approach for the primary repair of tracheoesophageal fistula (TEF) with esophageal atresia (EA) involves right thoracotomy with an extra-pleural approach, ligation of the Azygos vein, identification and ligation of the tracheoesophageal fistula, identification of the upper esophageal pouch, and end-to-end anastomosis. While primary esophageal repair with routine ligation of the Azygos vein is still performed, the modification of preserving the Azygos vein in appropriately selected cases, first defined in 1993 by Holder and colleagues, is widely used to date.^[4]

EA was repaired solely by thoracotomy until the thoracoscopic approach was first used by Lobe^[3] in 1999. Despite its short history, the thoracoscopic approach has been preferred by many surgeons. A study by Borruto et al.^[5] showed no significant difference in anastomosis leaks and strictures between classic thoracotomy and thoracoscopy. In a study by Rozeik et al.,^[6] 15 patients operated by thoracotomy were compared with 15 patients operated by thoracoscopy, and they reported a significantly increased rate of Azygos vein preservation among the thoracoscopy group. The Azygos vein was spared in all 15 patients in the thoracoscopy group (100%), while it was spared in only five patients (33.33%) in the thoracotomy group and divided in the remaining 10 patients (66.66%) to allow better visualization of the mediastinal structures.

Various studies have shown reduced rates of anastomotic leakage, anastomotic stricture, mortality, and postoperative pneumonitis among patients with preserved Azygos veins.^[4,7–9] Cui et al.^[7] compared 34 patients with preserved Azygos veins and 36 patients with divided Azygos veins, showing significant differences in anastomotic strictures. However, other studies have shown similar stricture rates among cases with preserved or ligated Azygos veins.^[9–11] One study by Fathi et al.^[12] showed no differences between the groups regarding anastomosis leakage, hemorrhage, infection, or duration of NICU stay. Although rare, the combination of Azygos vein agenesis and EA has been reported.^[13–16] In our study, only one patient with Azygos vein agenesis was seen among 30 patients operated within 5 years; this patient was excluded from the study.

A recent study from Türkiye evaluated 315 patients diagnosed with EA between 2015 and January 2020, whose data were obtained from the Turkish Esophageal Atresia Registry (TEAR). It reported that the classic approach showed significantly higher rates of respiratory problems requiring long-term medication compared to the 44 cases (14%) with preserved Azygos vein^[10]. In our study, no patients experienced anastomotic leakage, anastomosis detachment, or fistula recurrence, aligning with literature findings. Given that these patients often have associated congenital anomalies and that postoperative complications depend on multiple factors, pinpointing the exact effect of altering one variable is challenging. Cui et al.^[7] reported a similar incidence of associated anomalies in cases with preserved and divided Azygos veins. Soyer et al.^[10] reported significantly higher rates of associated anomalies in cases with divided Azygos veins (73.5% vs. 58.1%). In our study, 55.5% of patients with preserved Azygos veins also had additional anomalies. Four patients required dilatations due to anastomotic stenosis. In 3 patients, the fistula diameter was narrow, and the other patient had a long gap. Anastomotic stenosis is known to be related to the gap between esophageal ends and

the diameter of the fistula; however, other studies have not provided information on these variables, which may explain why our results differed from those in the literature. Despite these differences, we believe our results are valid.

Our study is a non-randomized retrospective study with various limitations, such as a small sample size and short and varying follow-up durations. However, unlike most studies in the literature, all patients in our study were operated on by the same surgeon, and different variables were considered when evaluating the outcomes, which can be seen as strengths of our study. Knowing that the Azygos vein can be preserved is useful for planning an appropriate management strategy to help reduce significant morbidity in cases with esophageal atresia. However, further prospective and comparative studies with larger sample sizes are needed. In light of this information, a new study is planned to show the effect of ligating the Azygos vein on morbidity and mortality, comparing all cases operated on for esophageal atresia.

CONCLUSION

Postoperative anastomosis leakage, fistula and stenosis are the most common complications observed after neonatal EA repair which increase mortality and morbidity. During primary esophageal repair, preservation of the Azygos vein, which significantly contributes to the drainage of the esophagus, should be preferred unless it increases intraoperative risk.

Statement

Ethics Committee Approval: The Zeynep Kamil Clinical Research Ethics Committee granted approval for this study (date: 08.07.2020, number: 141).

Author Contributions: Concept – AC; Design – AC; Supervision – AC; Materials – GIS, CG, SMT, AC; Data Collection and/or Processing – GIS, CG, SMT, AC; Analysis and/or Interpretation – GIS, CG, SMT, AC; Literature Search – AC, CG; Writing – GIS, SMT, CG; Critical Reviews – AC.

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REFERENCES

1. Leven NL. Congenital atresia of the esophagus with tracheoesophageal fistula: Report of successful extrapleural ligation of fistulous communication and cervical esophagostomy. *J Thorac Cardiovasc Surg* 1941;10:648–57.
2. Ladd WE. The surgical treatment of esophageal atresia and tracheoesophageal fistulas. *N Eng J Med* 1944;230:625–37.
3. Lobe TE, Rothenberg S, Waldschmidt J, Stroedter L. Thoracoscopic repair of esophageal atresia in an infant: A surgical first. *Pediatr Endosurg Innov Tech* 1999;3:141–8.
4. Sharma S, Sinha SK, Rawat JD, Wakhlu A, Kureel SN, Tandon R. Azygos vein preservation in primary repair of esophageal atresia with tracheoesophageal fistula. *Pediatr Surg Int* 2007;23:1215–8.

5. Borruto FA, Impellizzeri P, Montalto AS, Antonuccio P, Santacaterina E, Scafari G, et al. Thoracoscopy versus thoracotomy for esophageal atresia and tracheoesophageal fistula repair: Review of the literature and meta-analysis. *Eur J Pediatr Surg* 2012;22:415–9.
6. Rozeik AE, Elbarbary MM, Saleh AM, Khodary AR, Al-Ekrashy MA. Thoracoscopic versus conventional open repair of tracheoesophageal fistula in neonates: A short-term comparative study. *J Pediatr Surg* 2020;55:1854–9.
7. Cui X, He Y, Chen L, Lin Y, Wang Y, Zhang J, et al. Clinical analysis of azygos vein preservation under thoracoscope in the operation of type III esophageal atresia. *J Laparoendosc Adv Surg Tech A* 2020;30:448–52.
8. Rashid KA, Maletha M, Khan TR, Wakhlu A, Rawat J, Kureel SN. Esophageal anastomosis medial to preserved azygos vein in esophageal atresia with tracheoesophageal fistula: Restoration of normal mediastinal anatomy. *J Neonatal Surg* 2012;1:50.
9. Upadhyaya VD, Gangopadhyaya AN, Gopal SC, Upadhyaya A, Sharma SP, Gupta DK, et al. Is ligation of azygos vein necessary in primary repair of tracheoesophageal fistula with esophageal atresia? *Eur J Pediatr Surg* 2007;17:236–40.
10. Soyer T, Öztörün Cİ, Fırıncı B, Durakbaşa ÇU, Bahadır GG, Karaman A, et al. The effect of azygos vein preservation on postoperative complications after esophageal atresia repair: Results from the Turkish Esophageal Atresia Registry. *J Pediatr Surg* 2021;56:1940–3.
11. Fonte J, Barroso C, Lamas-Pinheiro R, Silva AR, Correia-Pinto J. Anatomic thoracoscopic repair of esophageal atresia. *Front Pediatr* 2017;4:142.
12. Fathi M, Joudi M, Morteza A. Evaluating necessity of azygos vein ligation in primary repair of esophageal atresia. *Indian J Surg* 2015;77(Suppl 2):543–5.
13. Mirza B, Saleem M. Agenesis of azygos vein in a case of esophageal atresia and tracheoesophageal fistula. *J Neonatal Surg* 2013;2:38.
14. Gupta DK, Arora M, Srinivas M. Azygos vein anomaly: The best predictor of a long gap in esophageal atresia and tracheoesophageal fistula. *Pediatr Surg Int* 2001;17:101–3.
15. Arslan G, Ozkaynak C, Cubuk M, Sindel T, Lüleci E. Absence of the azygos vein associated with double superior vena cava--a case report. *Angiology* 1999;50:81–4.
16. Arbell D, Golender J, Khalailieh A, Gross E. Search for the azygos: A lesson learnt from a case with left superior vena cava, esophageal atresia and tracheo-esophageal fistula. *Pediatr Surg Int* 2009;25:121–2.