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Postoperative Complications of Esophageal Atresia and Role of Endoscopic Balloon Dilatation in Anastomotic Strictures

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ABSTRACT

Purpose: Esophageal atresia (EA) with or without tracheoesophageal fistula (TEF) is a congenital anomaly that can cause frequent digestive and nutritional problems, even after repair. The most common complication is anastomotic stricture, for which reoperation or balloon dilatation is performed. This study aimed to evaluate the postoperative complications of EA and the role of endoscopic balloon dilatation (EBD) in cases of anastomotic stricture.

Methods: We retrospectively analyzed patients diagnosed with EA with or without TEF between January 2000 and February 2021. Patients' baseline characteristics, associated anomalies, and postoperative complications were reviewed.

Results: Among 26 patients, 14 (53.8%) were male, 12 (46.2%) had coexisting anomalies, and the median follow-up was 6.1 years (range, 1.2–15.7 years). In univariate analysis, prematurity, low birth weight, and long-gap EA were associated with postoperative complications in 12 (46.2%) patients. Among the 10 (38.5%) patients with anastomotic stricture, nine (90.0%) required EBD. Regarding the first EBD, it was performed at a median of 3.3 months (range, 1.2–7.6 months) post-repair, while the average patient weight was 4.6 kg. The mean diameter ranged from 3.3 to 9.1 mm without major complications. In univariate analysis, long-gap EA alone was significantly associated with EBD.

Conclusion: Approximately half of the patients experienced complications after EA repair. In particular, patients with a long-gap EA had a significantly increased risk of complications, such as anastomotic strictures. EBD can be safely used, even in infants.

Keywords: Anastomosis, surgical; Esophageal atresia; Balloon dilatation

Conflict of Interest

The authors have no financial conflicts of interest.

INTRODUCTION

Esophageal atresia (EA) with or without tracheoesophageal fistula (TEF) is a congenital condition that occurs in approximately 1 in every 2,500 to 4,500 newborns [1] and can be repaired by primary anastomosis of the proximal and distal esophagus, with concurrent ligation of any TEF [2]. EA is associated with other congenital and chromosomal anomalies, such as deletions of 22q11, trisomy 18, trisomy 21, or a combination of these [3].

After repair, various gastrointestinal and respiratory complications may occur [4]. Dysphagia secondary to anastomotic strictures, esophageal outlet obstruction, and dysmotility mainly contribute to feeding and nutritional problems [5]. Among these, anastomotic stricture occurs in 9–79% of cases [6], and fluoroscopic or endoscopic balloon dilatation (EBD) is considered the first-line treatment [7,8].

EBD is a simple procedure that does not involve radiation exposure. Direct observation of the stenotic segment and its improvement after the procedure can be achieved through endoscopy. However, data on postprocedural complications, safety, and long-term improvement in clinical conditions after EBD are scarce. Hence, this study aimed to evaluate the incidence of EA complications after repair and the related factors. Furthermore, we evaluated the role of EBD in anastomotic strictures in infants.

MATERIALS AND METHODS

We evaluated patients diagnosed with EA with or without TEF between January 2000 and February 2021. Their medical records were retrospectively reviewed for sex, gestational age, birth weight, associated anomalies, EA type, and postoperative complications. Postoperative complications were categorized as anastomotic strictures and leakages, gastroesophageal reflux, and recurrent tracheoesophageal fistulas. Patients underwent barium esophagography to identify strictures when they had dysphagia or swallowing difficulties (**Fig. 1**). EBD was performed using through-the-scope (TTS) balloon dilators (Boston Scientific, Marlborough,

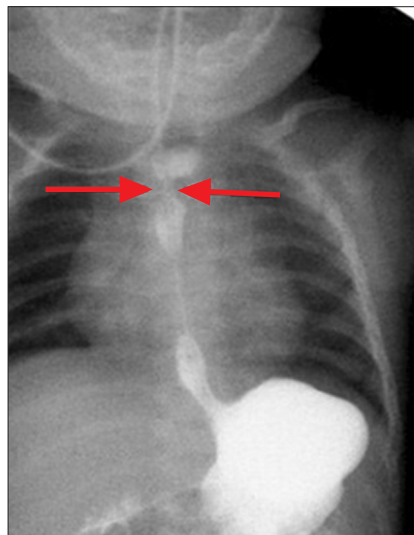


Fig. 1. Barium esophagography shows short segment of proximal esophageal stricture.

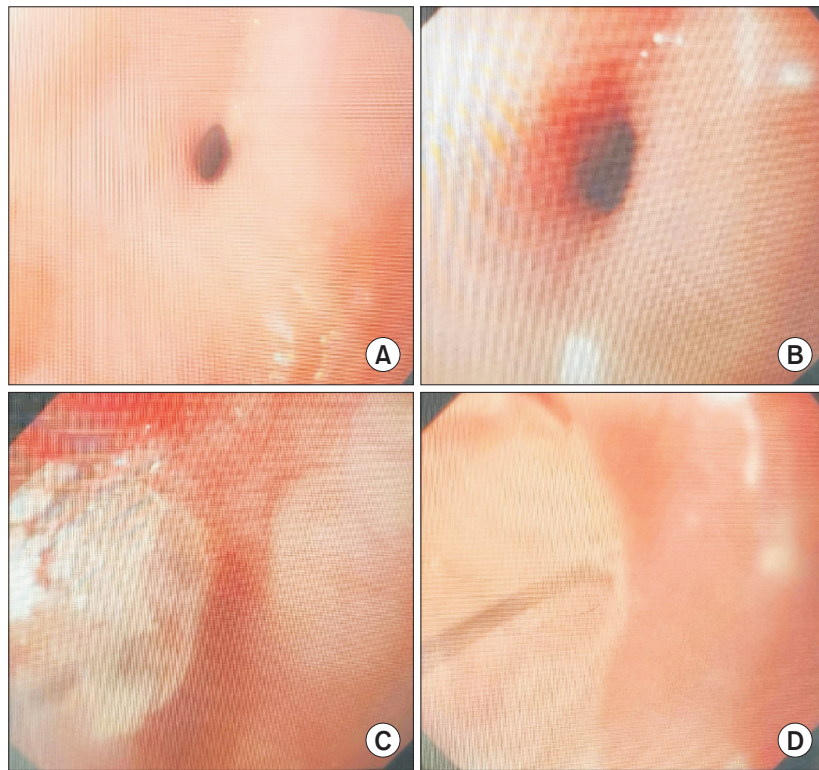


Fig. 2. Endoscopic view of esophageal stricture before (A) and after (B) dilatation, and balloon dilatation (Boston Scientific, Marlborough, MA, USA) was introduced and positioned across the stricture (C, D).

MA, USA) (**Fig. 2**). A long-gap was defined as a gap length between the upper and lower esophageal segments longer than 3 cm or greater than the height of two vertebral bodies [9]. A scope (GIF-Q230; Olympus, Tokyo, Japan) and a scope with a thin outer diameter (XP260N; Olympus) were used for the TTS and over-the-wire techniques, respectively.

To obliterate the stricture or increase the esophageal diameter, EBD was performed monthly in some cases, with a duration of 1–2 minutes each. The subsequent dilation diameter was set to increase by 1–2 mm. To evaluate nutritional status, we measured the z-scores of height, weight, and weight-for-height according to age.

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 24.0 (IBM Co., Armonk, NY, USA). Continuous data were expressed as median or mean (\pm standard deviation) and interquartile range. We compared these data using the Mann–Whitney U-test or Student's *t*-test. Discrete data were expressed as numbers and percentages and were compared using Fisher's exact or chi-square tests. We used the odds ratio (OR) for the logistic regression models to evaluate the factors associated with postoperative complications and EBD for EA. Statistical significance was set at $p < 0.05$.

This retrospective analysis was approved by the Institutional Review Board of Chungnam National University Hospital and was conducted in accordance with the Declaration of Helsinki (IRB number: 2021-04-042). The requirement for informed consent was waived owing to the retrospective nature of the study.

RESULTS

Of the 26 patients, 14 (53.8%) were male and 12 (46.2%) were female. The median gestational age and birth weight were 37+1 weeks (range, 29–41 weeks) and 2.46 kg (range, 0.91–3.32 kg), respectively. Twelve were preterm infants and 10 had a bodyweight <2.5 kg. The most common EA observed was gross type C. Coexisting anomalies were found in 12 (46.2%) patients and 22 cases with the following etiologies: cardiac (9 cases, 40.9%), gastrointestinal (5 cases, 22.7%), renal (3 cases, 13.6%), skeletal (3 cases, 13.6%), chromosomal anomaly (1 case, 4.6%), and VACTER association (1 case, 4.6%). Moreover, postoperative complications occurred in 12 (46.2%) patients and 23 cases. Early complications of anastomotic strictures, leakage, and TEF recurrence occurred in 10 (43.5%), 3 (13.0%), and 2 (8.7%) cases, respectively. Late complications of gastrointestinal reflux occurred in eight (34.8%) cases. These complications were associated with prematurity, low birth weight, and long-gap EA. Furthermore, patients with postoperative complications had lower height-for-age and weight-for-height z-scores than those without. However, no significant differences were observed. The baseline characteristics of the patients, according to the presence of postoperative complications, are presented in **Table 1**.

In multivariate analysis, long-gap EA was associated with a significantly increased risk (OR: 4.48, confidence interval [CI]: 0.68–19.78, $p=0.047$) of postoperative complications. **Table 2** shows the univariate and multivariate analyses of the risk factors for postoperative complications in EA. The year of operation and operation method had no significant effect on postoperative complications.

Of the 10 patients with anastomotic strictures, nine underwent EBD at a median of 3.3 months (range, 1.2–7.6 months) post-repair, with an initial median weight of 4.6 kg (range, 3.1–6.4 kg). The esophageal diameter increased from 3.3 to 9.1 mm after performing EBD an average of three times. Moreover, no significant complications were noted. The median follow-up period was 4.4 years (range, 0.4–9.9 years), while seven (77.8%) patients had full

Table 1. Baseline characteristics of patients according to the presence of postoperative complications

Variable	Total N=26	Postoperative complications (+) N=12	Postoperative complications (-) N=14	p-value
Male	14 (53.8)	8 (66.7)	6 (42.9)	0.207
Birth weight (kg)				0.044
Normal (≥ 2.5)	16 (61.5)	5 (41.7)	11 (78.6)	
Low birth weight (<2.5)	10 (38.5)	7 (58.3)	3 (21.4)	
Gestational age (wk)				0.042
Normal (≥ 37)	14 (53.8)	4 (33.3)	10 (71.4)	
Prematurity (<37)	12 (46.2)	8 (66.7)	4 (28.6)	
Type of EA				0.049
A	1 (3.8)	1 (8.3)		
B	1 (3.8)	1 (8.3)		
C	24 (92.4)	10 (83.4)	14 (100.0)	
Associated anomalies	12 (46.2)	4 (33.3)	8 (57.1)	0.225
Long-gap EA	10 (38.5)	7 (58.3)	3 (21.4)	0.043
Last WFH z-score	-0.57±1.39	-0.69±1.61	-0.41±1.15	0.302
Last height-for-age z-score	-1.31±1.87	-1.94±1.89	-0.55±1.62	0.456

Values are presented as number (%) or mean±standard deviation.

EA: esophageal atresia, WFH: weight-for-height.

Postoperative complications included early (anastomotic stricture, leakage, and tracheoesophageal fistula recurrence) and late (gastroesophageal reflux) complications. Associated anomalies included cardiac, gastrointestinal, renal, skeletal, and chromosomal anomalies, and VACTER association.

Table 2. Univariate and multivariate analyses of risk factors for postoperative complications in patients with esophageal atresia

Variable	Univariate analysis	p-value	Multivariate analysis	p-value
	OR (95% CI)		OR (95% CI)	
Male	2.67 (0.53–13.21)	0.230		
Prematurity	5.00 (0.94–16.53)	0.049	2.66 (0.363–19.51)	0.136
Low birth weight	4.32 (0.82–15.32)	0.042	3.00 (0.379–13.51)	0.198
Long-gap EA	5.13 (0.92–18.57)	0.048	4.48 (0.685–19.78)	0.047
The year of operation (after 2014)	0.12 (0.01–1.21)	0.073		
Presence of associated anomalies	0.37 (0.076–1.85)	0.230		

EA: esophageal atresia, OR: odds ratio, CI: confidence interval.

Postoperative complications included early (anastomotic stricture, leakage, and tracheoesophageal fistula recurrence) and late (gastroesophageal reflux) complications.

Associated anomalies included cardiac, gastrointestinal, renal, skeletal, and chromosomal anomalies, and VACTER association.

Table 3. Baseline characteristics of the patients who underwent EBD for anastomotic strictures

Variable	1	2	3	4	5	6	7	8	9
Sex	F	M	M	F	F	M	M	M	F
Birth weight (kg)	2.58	3	3.01	0.91	2.27	2.33	2.83	2.93	2.79
Gestational age (wk)	39+4	41	36+1	29	35+4	36+2	38+3	39	35+6
Weight at first EBD (kg)	6.4	6.3	3.7	3.1	4.2	3.1	4.0	6.0	4.2
Days after EA repair (mo)	4.1	2.7	1.2	4.4	5.4	1.2	1.7	7.6	1.7
Type of EA	C	C	C	C	B	C	C	C	C
Length of gap	Long	Long	Short	Long	Long	Short	Long	Long	Short
Location of stricture	Upper	Upper	Middle	Upper	Upper	Middle	Upper	Middle	Upper
Diameter before first EBD (mm)	4	2.5	4	3	3	3	2	5	3
Diameter after final EBD (mm)	10	11	11	9.5	6	6	7	10	11
Follow-up period after birth (yr)	8.1	7.2	2.6	3.2	0.5	1.8	0.4	9.9	5.9
Number of EBD	2	6	5	3	1	2	4	3	4
Last weight-for-height z-score	0.15	1.53	-2.76	0.30	-0.70	-2.68	-1.20	1.16	-2.54
Last height-for-age z-score	-0.19	-0.41	-1.14	-4.13	-0.90	-5.50	0.50	-0.85	-3.00
Complication	None	Minor bleeding	Minor bleeding	Minor bleeding	None	None	Minor bleeding	None	None

EA: esophageal atresia, EBD: endoscopic balloon dilatation, F: female, M: male.

Table 4. Univariate analysis of risk factors for endoscopic balloon dilatation in patients with esophageal atresia

Variable	Univariate analysis	p-value
	OR (95% CI)	
Male	1.11 (0.21–5.63)	0.899
Prematurity	3.66 (0.66–10.19)	0.135
Low birth weight	1.40 (0.25–7.58)	0.696
Long-gap EA	6.50 (1.09–18.63)	0.040
Presence of associated anomalies	0.90 (0.17–4.56)	0.899

EA: esophageal atresia, OR: odds ratio, CI: confidence interval.

Associated anomalies included cardiac, gastrointestinal, renal, skeletal, and chromosomal anomalies, and VACTER association.

dietary intake without any supplemental feeding gastrostomy or nasogastric tube at the last follow-up. Patients who underwent EBD had a lower height-for-age z-score than those who did not; nevertheless, their growth was relatively good. **Table 3** shows the baseline characteristics of the patients who underwent EBD.

In the univariate analysis of the factors related to EBD (**Table 4**), only long-gap EA had a significant association (OR: 6.50, CI: 1.09–18.63, $p=0.040$).

DISCUSSION

In this study, approximately half of the patients with EA had complications after repair, with the length of the esophageal gap being the most significant risk factor for complications. Postoperative complications occurred less frequently than in other studies (60–70%). Meanwhile, anastomotic stricture and gastrointestinal reflux were the most common complications, similar to other studies [10-12]. The anastomotic stricture was managed by EBD, and patients had relatively good nutritional status at the final follow-up.

Many studies have considered prematurity and low birth weight to be important factors for postoperative complications and poor growth in patients with EA [13-15]. A previous study [16] reported the importance of birth weight and a significant association between weight-for-height at birth and 2 years of age. In the present study, low birth weight and prematurity were related to postoperative complications. However, no association was observed between each variable in the multivariate analysis. Moreover, associated cardiovascular anomalies are regarded as important prognostic factors in EA; consequently, we found no association between these [1,10].

Additionally, long-gap EA has been considered a significant risk factor for postoperative complications [17,18]. Rassiwala et al. [19] reported an inverse correlation between gap length and birth weight. Tension on anastomosis may explain the high risk of anastomotic complications in patients with a long-gap [20,21], which was associated with both postoperative complications and EBD in this study. Therefore, more attention should be paid to patients with a long-gap to improve their prognosis.

Studies on EBD in children, especially in infants, are scarce. Chang et al. [12] reported the safety of EBD in children under 6 years of age, and Chang et al. [22] showed an overall clinical success rate of EBD as high as 72% with significantly increased weight-for-age z-scores. In our study, approximately 78% of patients had an oral diet with a median follow-up period of 4.4 years, and no major complications occurred during EBD. Our study had some limitations. First, the retrospective design of the study affected the variables used in the analysis. Second, the sample size was too small for a generalized conclusion. However, we evaluated infants who had their first EBD under 1 year with a median weight of 4.6 kg and successfully treated anastomotic stricture, which can be the most significant EA repair complication that leads to poor growth.

In conclusion, the esophageal gap length was a significant risk factor for complications, including anastomotic stricture. EBD can be used safely and efficiently even in infants.

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