

ORIGINAL ARTICLE

Anti-reflux medication after esophageal atresia repair: a retrospective study from a tertiary center in Saudi Arabia

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ABSTRACT

Background: Esophageal atresia (EA), frequently associated with tracheoesophageal fistula (TEF), is the most common congenital anomaly of the esophagus. Although survival after surgical repair has improved substantially, gastroesophageal reflux disease (GERD) remains a frequent postoperative complication. Proton pump inhibitors (PPIs) are commonly prescribed to reduce GERD-related complications, including anastomotic stricture; however, evidence supporting their effectiveness is conflicting. This study evaluated the association between postoperative PPI use and outcomes, including esophageal stricture formation, in children undergoing EA repair at a tertiary center.

Methodology: This retrospective cohort study included patients with EA managed at King Fahad Medical City, Riyadh, Saudi Arabia, between January 1, 2010, and December 30, 2021. Patients treated initially at another institution, those who died before or after repair because of unrelated comorbidities, patients with long-gap EA or complex surgical procedures, and those with type E TEF were excluded. Demographic, clinical, operative, postoperative, and follow-up data were abstracted from medical records. Categorical variables were compared using Fisher's exact test. A two-sided p value <0.05 was considered statistically significant.

Results: Thirty-three patients were included; 20 (60.6%) were male, and 30 (90.9%) had type C EA. Primary one-stage repair was performed in 31 patients (93.9%), and open repair in 30 (90.9%). Esophageal strictures developed in 11 patients (33.3%). Among patients with strictures, 10 underwent endoscopic dilatation, and six required one to three dilatation sessions. Anti-reflux surgery was performed in two patients with strictures. Strictures were more frequent in patients with type A or B EA than in those with type C EA (3/3 vs. 8/30; $p = 0.037$). A two-stage repair was also associated with stricture formation (2/2 vs. 9/31 after one-stage repair; $p = 0.039$). We did not detect a significant association between postoperative PPI use and stricture formation ($p = 0.706$), and PPI-treatment duration was not significantly associated with study outcomes.

Conclusions: In this single-center retrospective cohort, we did not detect an association between routine postoperative PPI therapy and a lower incidence of esophageal stricture after EA repair; given the small sample size, this may reflect limited statistical power rather than a true absence of effect. Stricture formation appeared more strongly associated with anatomic complexity and staged repair. Larger prospective studies with objective GERD assessment are needed to define which patients benefit from acid-suppressive therapy after EA repair.

Keywords: Esophageal atresia, tracheoesophageal fistula, proton pump inhibitors, gastroesophageal reflux disease, anastomotic stricture, pediatric surgery.

Introduction

Esophageal atresia (EA) is the most common congenital anomaly of the esophagus, characterized by a congenital discontinuity of the esophagus, with or without an associated tracheoesophageal fistula (TEF). EA was first described in 1679, and the first successful surgical repair was reported in 1941 [1]. Internationally, the incidence of EA ranges from 1 in 2,500 to 1 in 4,500 live births, with

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a slight male predominance [2,3]. The globally accepted classification categorizes EA into five types according to the location of the atresia and the presence of a TEF: type A, EA without TEF (8%); type B, EA with a proximal TEF (3%); type C, EA with a distal TEF (85%; the most common type); type D, EA with both proximal and distal TEF without EA (4%) [1]. TEFs (<1%); and type E,

Advancements in antenatal detection methods, neonatal intensive care, neonatal anesthesia, and surgical techniques have significantly improved survival rates among patients with EA. Mortality is now predominantly limited to those with coexisting major congenital anomalies that impact the patient's overall condition and surgical decision-making [1,4]. Despite the high success rates of surgical treatment, several complications can arise during the postoperative course. Among these, gastroesophageal reflux disease (GERD) is the most common, with an incidence reported to reach up to 75% [4,5]. There is considerable debate regarding the optimal postoperative management of GERD in EA patients.

Gastroesophageal reflux (GER) is the involuntary passage of gastric contents into the esophagus. When GER causes symptoms or affects the patient's quality of life, it becomes classified as GERD [6]. In patients post-EA repair, GERD may result from several factors, including delayed primary repair, anastomotic tension, and neurogenic disturbances [3]. GERD is traditionally considered a risk factor for the development of anastomotic strictures in infants following EA surgical repair, along with other short- and long-term complications such as peptic esophagitis, gastric metaplasia and Barrett's esophagus, feeding disorders, dysphagia, and esophageal dysmotility. These issues can persist not only during the first years of life but also into adolescence and adulthood [4,7].

Several studies support the use of proton pump inhibitors (PPIs) to reduce the risk of GERD and its associated complications [8]. The latest ESPGHAN-NASPGHAN guidelines recommend treating GERD up to the first year of life with PPIs as first-line therapy to prevent postoperative complications in all patients with EA [8]. However, despite these expert recommendations, the literature does not consistently support this practice. A 2018 meta-analysis challenges the use of anti-reflux medications for preventing strictures post-EA repair, as the inflammatory process in EA patients is not solely driven by acid reflux [5].

While multiple studies have been conducted, most have not shown a significant reduction in stricture formation with the use of PPIs [5,7,9]. However, their potential benefits cannot be completely ruled out, highlighting the need for further well-controlled prospective studies to determine the appropriate duration and dosage of these medications [9].

At our center, the decision to administer PPIs is typically based on the surgeon's preference. Our observations indicate that patients who received PPIs had similar stricture rates compared to those who did not. This led us to review the medical records of our patients and statistically analyze whether the routine use of anti-

reflux medication reduces the incidence and severity of GERD and its related complications after EA repair. The objective of our study was to evaluate the outcomes of patients who routinely received anti-reflux medications following EA surgical repair and compare them to those who did not receive such treatment at our institution during the study period.

Methods

Study design and setting

This retrospective observational cohort study evaluated outcomes associated with postoperative anti-reflux medication use in children who underwent EA repair at King Fahad Medical City, Riyadh, Saudi Arabia. The study period extended from January 1, 2010, to December 30, 2021.

Participants

Eligible participants were patients diagnosed with EA who underwent treatment at King Fahad Medical City during the study period. Patients were excluded if they had undergone initial surgical management at another institution and were referred only for follow-up, died before or after surgical correction because of unrelated comorbidities, had long-gap EA or required complex surgical procedures, or had type E TEF without EA.

Data collection and outcomes

After Institutional Review Board approval, medical records were reviewed using a standardized data-collection form. Extracted data included demographic characteristics, antenatal diagnosis, EA type, associated anomalies, operative details, postoperative PPI treatment, complications, feeding milestones, stricture diagnosis and management, and follow-up duration. Postoperative PPI therapy consisted of omeprazole administered at a weight-based dose of 1 mg/kg/day. The decision to initiate PPI therapy, and its duration, was at the discretion of the treating surgeon; no standardized institutional protocol governed the agent, timing of initiation, or duration of therapy, and adherence to treatment was not formally assessed.

The primary outcome was postoperative esophageal stricture formation. Secondary outcomes included requirement for esophageal dilatation, number of dilatation sessions, anti-reflux surgery, postoperative complications, and factors associated with stricture formation.

Statistical analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 27.0 (IBM Corp., Armonk, NY). Categorical variables are presented as frequencies and percentages. Continuous variables are presented as mean $\pm$ SD or median, as appropriate. Because of the small sample size, associations between categorical variables and postoperative stricture formation were assessed using Fisher's exact test, and continuous variables were compared between groups using the Mann-Whitney

U test. Multivariable logistic regression to adjust for potential confounders was not performed because the number of outcome events (11 strictures) was insufficient to support a stable multivariable model; bivariate associations were therefore interpreted with caution. No a priori sample-size calculation was performed, and the study was underpowered to detect small-to-moderate differences. All tests were two-sided, and $p < 0.05$ was considered statistically significant.

Ethics approval and consent

The study was approved by the Institutional Review Board (IRB), King Fahad Medical City, Riyadh, Saudi Arabia (approval No. FWA00018774; approved November 24, 2022).

The requirement for informed consent was waived by the Institutional Review Board because this was a retrospective chart-review study involving previously collected, de-identified clinical data and posed no more than minimal risk to participants. All data were handled confidentially in accordance with applicable institutional and ethical requirements.

Results

Table 1 summarizes the demographic and clinical characteristics of the 33 participants. Twenty patients (60.6%) were male and 13 (39.4%) were female. Antenatal diagnosis was documented in 14 patients (42.4%). The most common presenting symptom was respiratory distress, reported in 16 patients (48.5%), followed by inability to pass a nasogastric tube in 12 (36.4%) and excessive salivation in five (15.2%). Regurgitation was reported in one patient (3.0%), whereas seven patients (21.2%) had no documented presenting symptoms. Associated congenital anomalies were common, particularly cardiovascular anomalies, which were present in 21 patients (63.6%). The mean birth weight was 2457 ± 620 g, and the mean gestational age was 37.0 ± 2.2 weeks. Birth weight, gestational age, and age at surgery did not differ significantly between the PPI and non-PPI groups or between patients with and without strictures.

Table 2 provides a detailed overview of the surgical management and operative characteristics of 33 study participants with EA. The majority of cases were classified as Type C EA with distal TEF (90.9%, $n = 30$), while Type A (3.0%, $n = 1$) and Type B (6.1%, $n = 2$) were rare. The estimated gap length was less than 4 cm in 90.9% ($n = 30$) of cases, with only 9.1% ($n = 3$) having a gap length exceeding 4 cm. Signs or features of known syndromes or associations were present in 9.1% ($n = 3$) of participants. On the other hand, the majority (90.9%, $n = 30$) had no such features. Surgical management was predominantly performed in one stage (93.9%, $n = 31$), with only 6.1% ($n = 2$) requiring a two-stage approach. The age at surgery varied, with 51.5% ($n = 17$) undergoing surgery within 0–3 days of life, followed by 24.2% ($n = 8$) within 4–7 days. A smaller proportion underwent surgery after 15 days (9.1%, $n = 3$). The operative approach was primarily open (90.9%, $n = 30$), with minimal use of minimally invasive surgery (MIS) (6.1%,

Table 1. Bio-demographic and clinical characteristics of study participants in tertiary center experience in Saudi Arabia ($n = 33$).

	<i>n</i>	<i>n</i> (%)
Gender		
Male	20	60.6%
Female	13	39.4%
Antenatal diagnosis		
Yes	14	42.4%
No	19	57.6%
Presenting symptoms		
Respiratory distress	16	48.5%
Inability to pass NGT	12	36.4%
Salivation	5	15.2%
Regurgitation	1	3.0%
None	7	21.2%
Congenital anomalies		
Cardio-vascular anomalies	21	63.6%
Central nervous anomalies	3	9.1%
Musculoskeletal anomalies	4	12.1%
Genitourinary anomalies	9	27.3%
Pulmonary anomalies	5	15.2%
Other major congenital anomalies	19	57.6%
Patient's weight by grams		
<1000g	1	3.0%
1000–1499 g	1	3.0%
1500–1999 g	5	15.2%
2000–2499 g	9	27.3%
2500–2999 g	11	33.3%
3000–3499 g	5	15.2%
3500–4000 g	1	3.0%
Patient's birth weight by grams		
Range	910–3960	
Mean $\pm$ SD	2457 $\pm$ 620	
Median	2500	
Gestational age by weeks		
Range	32–40	
Mean $\pm$ SD	37.0 $\pm$ 2.2	
Median	38	

$n = 2$) or mixed approaches (3.0%, $n = 1$). Fistula ligation was most commonly performed using a tie (81.8%, $n = 27$), and the pleural approach was predominantly extra-pleural (69.7%, $n = 23$). Anastomosis under tension was reported in 27.3% ($n = 9$) of cases, while 72.7% ($n = 24$) had no tension. Intraoperative nasogastric tube (NGT) placement was universal (100.0%, $n = 33$), reflecting a standardized practice in this cohort.

Table 3 reveals postoperative management strategies and outcomes for 33 study participants. PPI therapy was widely used, with 87.9% ($n = 29$) of participants receiving PPIs postoperatively. Among these, all were administered a dosage of 1 mg/kg/day. The duration of PPI therapy varied, with the majority (51.7%, $n = 15$) continuing treatment for more than 12 months, while

Table 2. Surgical management, and operative characteristics of study participants with esophageal atresia in tertiary center experience in Saudi Arabia ($n = 33$).

	<i>n</i>	<i>n (%)</i>
Classification		
Type A: esophageal atresia without tracheoesophageal fistula	1	3.0%
Type B: esophageal atresia with proximal tracheoesophageal fistula	2	6.1%
Type C: esophageal atresia with distal tracheoesophageal fistula	30	90.9%
Estimated gap length		
<4 cm	30	90.9%
>4 cm	3	9.1%
Signs and features of known syndromes or associations		
Yes	3	9.1%
No	30	90.9%
Surgical management approach		
One stage	31	93.9%
Two stages	2	6.1%
More than two stages	0	0.0%
Age at surgery (days)		
0–3 days	17	51.5%
4–7 days	8	24.2%
8–11 days	1	3.0%
12–15 days	4	12.1%
> 15 days	3	9.1%
Operative approach		
Open	30	90.9%
MIS	2	6.1%
Mixed	1	3.0%
Fistula ligation		
Tie	27	81.8%
Stable	6	18.2%
Pleural approach		
Extra-pleural	23	69.7%
Intra-pleural	10	30.3%
Anastomosis under tension		
Yes	9	27.3%
No	24	72.7%
Intraoperative NGT placement		
Yes	33	100.0%
No	0	0.0%

others were treated for shorter durations (1 month: 10.3%, $n = 3$; 3 months: 17.2%, $n = 5$; 6 months: 20.7%, $n = 6$). Postoperative complications were minimal, with only 9.1% ($n = 3$) of participants experiencing a leak, while the majority (90.9%, $n = 30$) had no complications. Feeding practices postoperatively showed that most participants started nasogastric or gastrostomy tube (NGT/GT) feeding within 4–7 days (51.5%, $n = 17$), with fewer requiring longer durations (>14 days: 12.1%, $n = 4$). Oral feeding was initiated within one week for 48.5% ($n = 16$) of participants, while 12.1% ($n = 4$) required more than three weeks to begin oral feeding.

Table 4 summarizes the characteristics and management of postoperative esophageal strictures. Esophageal strictures developed in 11 patients (33.3%). The most

common age at diagnosis was 4–6 months, occurring in four patients (36.4%). Strictures were diagnosed by upper gastrointestinal contrast study in seven patients (63.6%) and by esophagoscopy in four patients (36.4%). Ten of the 11 patients with strictures underwent esophageal dilatation; the remaining patient had missing data, dilations status could not be determined from the medical records. Of these, six required one to three dilatation sessions, two required four to six sessions, and two required more than six sessions. Anti-reflux surgery was performed in two patients with strictures. Most patients (75.8%) were followed for more than 12 months.

Table 5 explores the association between PPI use and various outcomes in the study cohort. Among participants who received PPIs (87.9%, $n = 29$), 34.5% ($n = 10$)

Table 3. Postoperative management and ppi intake of study participants with esophageal atresia in tertiary center experience in Saudi Arabia (n = 33).

Postoperative data	n	n (%)
Post-operative PPI		
Yes	29	87.9%
No	4	12.1%
Dosage of PPI (by mg/kg/day)		
1 mg/kg/day	29	100.0%
Duration of PPI (by months)		
>12 months	15	51.7%
1 month	3	10.3%
3 months	5	17.2%
6 months	6	20.7%
Postoperative complication		
Leak	3	9.1%
None	30	90.9%
Post-operative NGT/GT feeding day		
0–3 days	5	15.2%
4–7 days	17	51.5%
8–11 days	6	18.2%
12–14 days	1	3.0%
>14 days	4	12.1%
Post-operative oral feeding day		
1 week	16	48.5%
2 weeks	8	24.2%
3 weeks	5	15.2%
>3 weeks	4	12.1%

developed esophageal strictures, compared to 25.0% ($n = 1$) in the non-PPI group ($p = 0.706$). The age at stricture development and mode of diagnosis (esophagoscopy vs. UGI) also showed no significant differences between the PPI and non-PPI groups ($p = 0.402$ and $p = 0.428$, respectively). Similarly, the need for anti-reflux surgery was comparable between the two groups, with 18.2% ($n = 2$) of PPI users requiring surgery versus none in the non-PPI group ($p = 0.640$). The duration of follow-up was predominantly longer than 12 months in both groups (75.9% PPI users vs. 75.0% non-PPI users), with no significant difference ($p = 0.475$).

Table 6 presents factors associated with postoperative esophageal stricture formation. EA type was significantly associated with stricture formation ($p = 0.037$): strictures developed in all patients with type A or B EA (3/3) compared with 8 of 30 patients (26.7%) with type C EA. Surgical staging was also significantly associated with stricture formation ($p = 0.039$): strictures developed in both patients who underwent two-stage repair compared with 9 of 31 patients (29.0%) who underwent one-stage repair. No significant associations were observed for sex, antenatal diagnosis, estimated gap length, associated congenital anomalies, operative approach, or postoperative feeding practices.

Table 4. Esophageal stricture characteristics and management in study participants with esophageal atresia in tertiary center experience in Saudi Arabia (n = 33).

Stricture data	n	n (%)
Esophageal stricture		
Yes	11	33.3%
No	22	66.7%
Age at stricture development (by months)		
<3 months	3	27.3%
4–6 months	4	36.4%
10–12 months	1	9.1%
>12 months	3	27.3%
Mode of stricture diagnosis		
Esophagoscopy	4	36.4%
UGI	7	63.6%
Required dilatation		
Yes	10	90.9%
No	1	9.1%
Number of dilatations		
1–3 times	6	60.0%
4–6 times	2	20.0%
>6 times	2	20.0%
Required anti-reflux surgery		
Yes	2	18.2%
No	9	81.8%
Duration of follow-up		
0–3 months	2	6.1%
3 months	1	3.0%
4–6 months	4	12.1%
6 months	1	3.0%
>12 months	25	75.8%

One patient with a stricture was lost to follow-up after diagnosis; no dilatation or anti-reflux surgery was documented for this patient. Percentages are of the 11 patients with strictures, except number of dilatations (percentages of the 10 patients who underwent dilatation).

Discussion

In this single-center retrospective cohort of 33 children who underwent EA repair, we did not detect a significant association between routine postoperative PPI use and esophageal stricture formation ($p = 0.706$). By contrast, strictures were significantly more frequent in patients with type A or B EA (3/3 vs. 8/30 with type C; $p = 0.037$) and in those who underwent two-stage repair (2/2 vs. 9/31; $p = 0.039$), suggesting that anatomic complexity and staged reconstruction, rather than acid suppression, were the dominant correlates of stricture formation in this cohort.

These findings are consistent with a substantial portion of the literature. Several observational studies and a 2018 systematic review and meta-analysis by Miyake et al. found no clear evidence that prophylactic anti-reflux medications reduce anastomotic stricture formation after EA repair [5,7,9,10]. They nevertheless stand in contrast to the ESPGHAN-NASPGHAN guidelines, which recommend routine PPI therapy during the first year of

Table 5. Association between postoperative proton pump inhibitor (PPI) use and outcomes in study participants with esophageal atresia (n = 33).

Outcome	Post-operative PPI				p-value
	Yes		No		
	n	n (%)	n	n (%)	
Esophageal stricture					.706
Yes	10	34.5%	1	25.0%	
No	19	65.5%	3	75.0%	
Age at stricture development (by months)					.402
<3 months	3	30.0%	0	0.0%	
4–6 months	4	40.0%	0	0.0%	
10–12 months	1	10.0%	0	0.0%	
> 12 months	2	20.0%	1	100.0%	
Mode of stricture diagnosis					.428
Esophagoscopy	4	40.0%	0	0.0%	
vUGI	6	60.0%	1	100.0%	
Required anti-reflux surgery					.640
Yes	2	18.2%	0	0.0%	
No	9	81.8%	1	100.0%	
Duration of follow-up					.475
0–3 months	1	3.4%	1	25.0%	
3 months	1	3.4%	0	0.0%	
4–6 months	4	13.8%	0	0.0%	
6 months	1	3.4%	0	0.0%	
>12 months	22	75.9%	3	75.0%	

P: Exact probability test.

Table 6. Factors associated with esophageal stricture among patients with esophageal atresia (N = 33).

Factors		Esophageal stricture				p-value
		Yes		No		
		n	n (%)	n	n (%)	
Gender	Male	7	35.0%	13	65.0%	.801
	Female	4	30.8%	9	69.2%	
Antenatal diagnosis	Yes	7	50.0%	7	50.0%	.081
	No	4	21.1%	15	78.9%	
Classification	Type A	1	100.0%	0	0.0%	.037*
	Type B	2	100.0%	0	0.0%	
	Type C	8	26.7%	22	73.3%	
Estimated gap length	< 4 cm	10	33.3%	20	66.7%	.999
	> 4 cm	1	33.3%	2	66.7%	
Other major congenital anomalies	Yes	6	31.6%	13	68.4%	.803
	No	5	35.7%	9	64.3%	
Cardio-vascular anomalies	Yes	6	28.6%	15	71.4%	.443
	No	5	41.7%	7	58.3%	
Central nervous anomalies	Yes	1	33.3%	2	66.7%	.998
	No	10	33.3%	20	66.7%	
Musculoskeletal anomalies	Yes	0	0.0%	4	100.0%	.131
	No	11	37.9%	18	62.1%	
Genitourinary anomalies	Yes	3	33.3%	6	66.7%	.999
	No	8	33.3%	16	66.7%	
Pulmonary anomalies	Yes	1	20.0%	4	80.0%	.492
	No	10	35.7%	18	64.3%	
Signs and features of known syndrome or associations	Yes	0	0.0%	3	100.0%	.199
	No	11	36.7%	19	63.3%	

Continued

Factors		Esophageal stricture				p-value
		Yes		No		
		n	n (%)	n	n (%)	
Surgical management approach	One stage	9	29.0%	22	71.0%	.039*
	Two stages	2	100.0%	0	0.0%	
	More than two stages	0	0.0%	0	0.0%	
Age at surgery (days)	0–3 days	5	29.4%	12	70.6%	.580
	4–7 days	2	25.0%	6	75.0%	
	8–11 days	0	0.0%	1	100.0%	
	12–15 days	2	50.0%	2	50.0%	
	>15 days	2	66.7%	1	33.3%	
Operative approach	Open	9	30.0%	21	70.0%	.098
	MIS	2	100.0%	0	0.0%	
	Mixed	0	0.0%	1	100.0%	
Fistula ligation	Tie	9	33.3%	18	66.7%	.999
	Stable	2	33.3%	4	66.7%	
Postoperative complication	Leak	1	33.3%	2	66.7%	.999
	None	10	33.3%	20	66.7%	
Pleural approach	Extra-pleural	9	39.1%	14	60.9%	.284
	Intra-pleural	2	20.0%	8	80.0%	
Anastomosis under tension	Yes	3	33.3%	6	66.7%	.999
	No	8	33.3%	16	66.7%	
Intraoperative NGT placement	Yes	11	33.3%	22	66.7%	-
	No	0	0.0%	0	0.0%	
Post-operative NGT/GT feeding day	0–3 days	1	20.0%	4	80.0%	.159
	4–7 days	9	52.9%	8	47.1%	
	8–11 days	1	16.7%	5	83.3%	
	12–14 days	0	0.0%	1	100.0%	
	>14 days	0	0.0%	4	100.0%	
Post-operative oral feeding day	1 week	5	31.3%	11	68.8%	.258
	2 weeks	4	50.0%	4	50.0%	
	3 weeks	0	0.0%	5	100.0%	
	>3 weeks	2	50.0%	2	50.0%	
Presenting symptoms	Respiratory distress	4	25.0%	12	75.0%	.485
	Inability to pass NGT	3	25.0%	9	75.0%	
	Salivation	2	40.0%	3	60.0%	
	Regurgitation	0	0.0%	1	100.0%	
	None	4	57.1%	3	42.9%	

P: Exact probability test.

* $p < 0.05$ (significant).

life in all patients with EA [8]. Reports linking stricture formation to surgical and anatomic factors (including long-gap atresia, anastomotic tension, anastomotic leak, and staged repair) support our observation that operative complexity is a stronger determinant of stricture risk than acid exposure alone [11–15].

A plausible explanation is the multifactorial pathogenesis of anastomotic strictures. Although acid reflux contributes to mucosal injury at the anastomosis, tension-related ischemia and subsequent fibrosis, the size of the anastomotic gap, anastomotic leak, postoperative inflammation, and intrinsic patient characteristics all promote stricture development [11,14,16–19]. In our cohort, anastomotic tension and associated

congenital anomalies, including VACTERL-spectrum malformations [20], were not significantly associated with strictures, likely reflecting the small sample size and heterogeneous presentations rather than a true absence of effect. Acid suppression alone therefore appears insufficient to prevent a complication that is driven substantially by mechanical and healing-related factors.

These observations have practical implications. Long-term PPI use in children carries potential risks, including infections, bone fractures, and nutritional deficiencies [19,21], so indiscriminate routine prophylaxis may expose patients to harm without clear benefit. A more selective strategy of reserving acid suppression for patients with documented GERD (by symptoms, pH monitoring, or

endoscopy) or high-risk anatomy may be more rational, alongside an emphasis on meticulous surgical technique to minimize anastomotic tension, prevention and early recognition of leaks, and close postoperative surveillance [11–15]. We emphasize, however, that our data are insufficient to justify withholding PPIs, and practice should continue to be guided by prospective evidence and current guidelines until stronger data emerge.

Endoscopic dilatation remains the cornerstone of stricture management, and in our cohort 10 of the 11 patients with strictures underwent dilatation, most needing one to three sessions. Repeated dilatation is not without risk, as it predisposes to esophageal perforation, bleeding, and further scarring [22–24]. Emerging approaches, including biodegradable stents and anti-fibrotic agents, are under investigation and may eventually offer more durable relief with fewer procedures [25].

Strengths and limitations

This study addresses a clinically important question regarding the role of routine anti-reflux medication in preventing esophageal strictures after EA repair. By directly comparing outcomes in patients who did and did not receive routine PPI therapy within a uniform tertiary-care setting over an 11-year period, it offers real-world data relevant to current practice and to ongoing debate around guideline recommendations.

Several limitations should be considered when interpreting our findings. First, the sample size was very small ($n = 33$, with only 11 stricture events); the study was therefore underpowered to detect small-to-moderate differences, and the absence of a statistically significant association between PPI use and stricture formation should not be interpreted as evidence of equivalence or of no effect. Second, the small number of events precluded multivariable logistic regression, so the bivariate associations reported here are unadjusted and may be affected by confounding. Third, GERD was not objectively assessed: no systematic pH(-impedance) monitoring or endoscopic evaluation with biopsy was performed, so it is unknown whether PPI-treated patients had documented GERD or how severe it was. Fourth, because PPI prescribing was based on surgeon preference rather than a standardized protocol, confounding by indication is likely: patients perceived to be at higher risk (e.g., greater anastomotic tension or more complex anatomy) may have been more likely to receive PPIs, biasing results toward the null; the sample size did not permit propensity-score adjustment. Fifth, the PPI regimen was not standardized with respect to agent, timing of initiation, or duration, and adherence was not assessed. Sixth, excluding patients with long-gap EA, complex procedures, and those initially managed elsewhere introduces selection bias and limits generalizability, as does the retrospective, single-center design; our findings may not extend to centers with different prescribing practices. Finally, GERD symptoms, quality of life, and outcomes beyond the immediate postoperative period were not systematically evaluated.

Conclusion

In this small single-center cohort, we did not detect a significant association between routine anti-reflux medication use after EA repair and a reduced incidence of esophageal strictures. Because the study was underpowered, this finding does not establish equivalence or a lack of effect; rather, together with the observed associations with anatomic complexity and staged repair, it underscores the multifactorial nature of this complication. Acid suppression alone appears insufficient to prevent strictures. Given the uncertain benefits and potential risks associated with routine anti-reflux medication use in pediatric patients, our findings highlight the importance of a more selective approach, focusing on those with confirmed GER or specific high-risk factors. Future efforts should prioritize adequately powered, prospective multicenter studies incorporating objective GERD assessment (pH-impedance monitoring and endoscopy) and standardized PPI protocols, alongside refined surgical techniques and evidence-based postoperative pathways tailored to patient-specific risk profiles.

Conflict of interests

The authors declare that they have no competing interests.

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Ethics approval

This study was approved by the Institutional Review Board at King Fahad Medical City, Riyadh, Saudi Arabia (approval no. FWA00018774; approved November 24, 2022).

Consent to participate

The requirement for informed consent was waived by the Institutional Review Board because this was a retrospective chart-review study involving de-identified data and minimal risk to participants.

Consent for publication

Not applicable. No identifiable individual participant data are included in this manuscript.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available because they contain confidential patient information and are subject to institutional restrictions. De-identified data may be available from the corresponding author upon reasonable request and with approval from King Fahad Medical City.

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