ORIGINAL ARTICLE

Efficacy of Endoscopic Balloon Dilatation in Children with Esophageal Stricture

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ABSTRACT

Objective: To determine the efficacy of endoscopic balloon dilatation (EBD) in children with esophageal stricture.

Study Design: Prospective cross-sectional observational study.

Place and Duration of Study: Conducted at the Pediatric Gastroenterology Department of Children's Hospital Lahore during time period from January 3, 2024, to August 29, 2024.

Materials and Methods: A total of 47 patients (<18 years) with confirmed esophageal stricture of any etiology were included. Patients with a history of previous EBD, uncorrectable coagulopathy, recent upper gastrointestinal surgery or perforation, malignancy, or terminal illness were excluded. After ethical approval and informed consent, demographic details were collected. EBD was performed under general anesthesia. Efficacy was assessed by symptomatic relief, treatment response, weight gain, and need for repeat sessions. Data were analyzed using SPSS version 26.

Results: EBD was effective in 87% of patients, with 72.3% showing complete response and 87% demonstrating weight gain. Stratification by gender, age, site, size, and etiology revealed no significant difference in efficacy ($p > 0.05$). Patients with congenital strictures most often required only one session (66.7%), while those with chemical etiology required five to six sessions (100%, $p = 0.001$).

Conclusion: EBD was effective in 87% of children, providing symptomatic relief and complete response in 72.3%. Chemical strictures required more sessions compared to congenital cases. EBD is therefore a safe and beneficial therapeutic option, offering substantial and sustained symptom improvement in pediatric esophageal strictures.

Key Words: Endoscopic balloon dilatation, Esophageal stricture, Children

INTRODUCTION

Pediatric gastroenterologists frequently encounter benign esophageal strictures (ES) in children, which are defined as abnormal narrowing of the esophageal lumen.[1] Common causes of ES include congenital, gastroesophageal reflux disease, ingestion of corrosives, eosinophilic esophagitis, infections, inflammatory/autoimmune conditions, external compression, surgical

complications, and repeated injuries.[2] ES typically presents with persistent vomiting, difficulty swallowing, and unintentional weight loss. Incidence of ES is approximately 1 in 10,000 per year globally, with no clear association between genders.[3]

Pathophysiology of ES varies, but contributing factors are is damage to mucosal lining, leading to chronic inflammation, intramural fibrosis, and subsequent formation of strictures.[4] Esophageal strictures develop gradually, and prognosis is influenced by timing of diagnosis, and management. Therefore, it is important to diagnose and treat ES promptly to restore the esophageal lumen's patency.[5] The primary goal of treatment is to alleviate symptoms and prevent complications such as failure to thrive, malnutrition, dehydration, esophageal perforation, respiratory issues, recurrent infections, and upper gastrointestinal bleeding.[6] Upper GI endoscopy is essential for both diagnosing and treating ES, with treatment options including dilation, stenting, and surgical resection.[7]

Endoscopic balloon dilation (EBD), a medical procedure used to treat esophageal strictures, involves the use of endoscope, along with balloon catheter.[8] Balloon dilation is often first-line treatment in children due to its high success rate and low incidence of complications such as perforation and significant bleeding, along with discomfort and possibility of stricture recurrence.[9] The primary mechanisms for dilation in esophageal strictures typically involve either splitting the stricture or stretching it circumferentially. These methods aim to interrupt scar tissue remodeling before it becomes rigid.[10]

The effectiveness of the dilation procedure can be evaluated in two ways: directly through endoscopy by observing mucosal tearing at the site of the stricture, or indirectly through fluoroscopy, where the disappearance of the narrowing is observed.[11] The diameter, length, and number of strictures are key factors in predicting the clinical outcomes of endoscopic balloon dilation in pediatric esophageal strictures. Multiple dilation sessions may be necessary to effectively treat esophageal strictures and prevent recurrence, with longer strictures often requiring more sessions or surgical interventions.[12,13]

We are conducting this study, as there is significant lack of data on effectiveness of endoscopic balloon dilation in our locality with only 2 studies conducted previously, making it necessary to critically evaluate its outcomes and benefits in the local pediatric population. This study aimed to address this important gap by systematically investigating the efficacy and outcomes of endoscopic balloon dilation in children with esophageal strictures, ultimately enhancing patient care and advancing clinical practice in pediatric gastroenterology.

MATERIAL AND METHODS

This prospective cross-sectional observational study, conducted at Department of Pediatric Gastroenterology, Hepatology & Nutrition, The Children's Hospital & University of Child Health Sciences, Lahore. Study was conducted from 3-01-2024 to 29-08-2024. A total of 47 patients were included in the study as per defined inclusion and exclusion criteria. Included patients aged <18 years, both male and female with confirmed diagnosis of esophageal stricture of any etiology. Patients with contraindications to EBD (uncorrectable coagulopathy, recent upper gastrointestinal surgery, recent esophageal perforation, esophageal malignancy, terminally ill patient), a previous history of EBD, and those lost to follow-up were excluded.

Patients selection was done with non-probability consecutive sampling. This sample size of 47 patients was calculated using 95% confidence level, 10% margin of error and by taking expected percentage of symptomatic relief with EBD as 96.9%.[14].

Ethical approval was taken from Institutional ethical review board committee of Children hospital, Lahore with Serial number 757/CH-UCHS dated 2-01-2024. A total of 47 patients were included in the study over duration of 8 months, following approval of proposal. Written informed consent was obtained from each patient's parent/guardian prior to their participation in the study. Patients were recruited from the pediatric gastroenterology department of children hospital, Lahore. All information was recorded in pre designed proforma. Each patient's essential demographic information and etiology of

esophageal stricture was noted. Upon admission to the hospital, comprehensive medical history and thorough clinical examinations were conducted. Baseline hematological and radiological investigations required to meet the study's inclusion and exclusion criteria were performed. Before undergoing endoscopic balloon dilation (EBD), all patients have had contrast esophagogram performed to verify the site and length of the esophageal stricture, and findings were noted. All patients remained NPO for a period of 6 hours before procedure. Endoscopic balloon dilation (EBD) was performed with the patient under general anesthesia. The EBD balloon was advanced over an endoscopically placed guide wire and was gradually moved forward by 3 mm during each dilation, with a maximum of three increments in a single session. The position of the dilator was confirmed through endoscopy, and the dilator was left in place for 30 seconds to 1 minute before proceeding to the next dilation. At the end of procedure initial treatment response was recorded on the basis of stricture dilatation either full or partial, declared on assessment of performing gastroenterologist. Any complication if occurred was managed accordingly. In case of perforation, bleeding, or severe adverse events, a prompt referral to a surgeon was warranted. Patients with severe or complex strictures that may not be effectively managed with EBD alone were referred for the surgical evaluation. And these patients were not remaining the part of the study. All patients were observed in the procedure room for observation over a period of 2 hours and were given a proton-pump inhibitor (PPI) and intravenous fluids. All patients were followed over a period of 1 year for recurrence. Treatment efficacy was noted in terms of symptomatic relief using dysphagia scoring scale i.e. score equal or less than 1 at 4 weeks follow up was considered as effective. (Dysphagia Scoring Scale (0-4) 0 No dysphagia, 1 unable to swallow certain foods, 2 able to swallow only soft food, 3 able to swallow only liquids and 4 unable to swallow even liquids). The interval between next EBD sessions was 4 weeks if symptoms of obstruction were still present and it was decided according to radiology or endoscopy evaluation. IBM SPSS version 26 was used for data analysis. Mean ± SD was used to present quantitative variables and frequency and percentage was used to present qualitative variables. Data stratification was done (age, gender, site, length and etiology), for efficacy and post stratification chi square/Fischer's test was applied, p-value <0.05 was considered statistically significant.

RESULTS

Sociodemographic and disease related characteristics of our study population is mentioned in table I, showing mean age of 5.78 ± 3.29 years. There were more male patients 57% vs 43% females. Most common cause of stricture found to be chemical burn 70.2%, followed by congenital 14.9%, eosinophilic esophagitis 8.5% esophageal atresia 8.5%, and foreign body 2.1%. In the majority of patients, the stricture was found in the middle third (72.3%) of the esophagus followed by proximal (21.3%) and distal part of esophagus (6.4%). Length of stricture found to be <2 cm in 51% patients, 2-5cm in 43% patients and >5 cm in only 6% patients. The mean weight before the procedure and at the last follow up calculated was 15.95 ± 6.76kgs and 17.19 ± 6.90 kgs, respectively.

Initial treatment response noted to be partial in 25.5% patients, while 72.3% showed full treatment response and only 1 patient (2.1%) had no treatment response. Treatment efficacy was noted among 41 (87%) patients in terms of symptoms relief. Out of the total patients, 6.4% required only one session of EBD, while 10.7% required two sessions. The majority of patients required multiple sessions, with the highest proportion (29.8%) needing three sessions.

Data stratification with respect to gender, age, site, size and etiology of stricture has shown insignificant results for efficacy among stratified groups, $p > 0.05$ (as shown in table 3). Among the patients who required only one session, the majority had a congenital etiology (66.7%), whereas 33.3% had a chemical etiology. In contrast, all patients who required five and six sessions had chemical etiology (100%). This difference in the number of sessions required based on etiology was statistically significant ($p = 0.001$) as in table 4.

TABLE 1: Data stratification (n=47)

Age (Mean ± SD) years		5.78 ± 3.29
Gender	Male n (%)	27 (57.0)
	Female n (%)	20 (43.0)
Etiology of stricture	Congenital	07 (14.9)
	Chemical Burn	33 (70.2)
	Eosinophilic Esophagitis	04 (8.5)
	Esophageal Atresia	02 (4.3)
	Foreign Body	01 (2.1)
Site of stricture	Proximal	10 (21.3)
	Middle	34 (72.3)
	Distal	03 (6.4)
Length of stricture	<2cm	24 (51)
	2-5cm	20 (43.0)
	>5cm	03 (6.0)
Weight (kg) (Mean ± SD)	Before Procedure	15.95 ± 06.76
	After procedure	17.19 ± 6.90

TABLE 2 : Sociodemographic and disease related characteristics of patients (%)

Efficacy i.e.	**Yes**	**41 (87.0)**
Symptomatic Relief	No	06 (13.0)
	1	03 (6.4)
No of EBD sessions	2	05 (10.7)
required site of stricture	3	14 (29.8)
	4	12 (25.55)
	5	12 (25.5)
	6	01 (2.1)
Initial treatment response	Full	34 (72.3)
Length of stricture	Partial	12 (25.5)
	No res-ponse	01 /(2.1)
Dysphagia score	**0**	34 (72.3)
	1	05 (10.6)
Weight (kg) (Mean ± SD)	**2**	05 (10.6)
	3	02 (4.3)

TABLE 3: Data stratification

Groups		**Efficacy**		**Total (%)**	**p value**
		Yes (%)	**No (%)**		
Age	<9 years	37 (90.2)	4 (9.8)	41 (100.0)	
	9-18 years	05 (83.3)	1 (16.7)	06 (100.0)	0.60
	Total	**42 (89.4)**	**5 (10.6)**	**47 (100.0)**	
Gender	Male	25 (89.3)	3 (10.7)	28 (100.0)	
	Female	17 (89.5)	2 (10.5)	19 (100.0)	0.98
	Total	42 (89.4)	5 (10.6)	47 (100.0)	
Site	Proximal	09 (90.0)	1 (10.0)	10 (100.0)	
	Middle	30 (88.2)	4 (11.8)	34 (100.0)	0.81
	Distal	03 (100.0)	0 (0.0)	03 (100.0)	
	Total	**42 (89.4)**	**5 (10.6)**	**47 (100.0)**	
Length	<2cm	20 (83.3)	4 (16.7)	24 (100.0)	
	2-5cm	19 (95.0)	1 (5.0)	20 (100.0)	0.37
	>5cm	03 (100.0)	0 (0.0)	03 (100.0)	
	Total	**42 (89.4)**	**5(10.6)**	**47 (100.0)**	
Etiology	Congenital	06 (85.7)	1 (14.3)	07 (100.0)	
	Chemical	30 (91.0)	3 (9.0)	33 (100.0)	
	Esophageal atresia	01 (50.0)	1 (50.0)	02 (100.0)	0.40
	Foreign body	01 (100.0)	0 (0.0)	01 (100.0)	
	Eosinophilic esophagitis	04 (100.0)	0 (0.0)	04 (100.0)	
	Total	**42(89.4)**	**5(10.6)**	**47 (100.0)**	

TABLE 4: Need for next EBD session according to etiology

Etiology		**Sessions required**					
		1	**2**	**3**	**4**	**5**	**6**
Congenital	N	2	0	3	2	0	0
	%	66.7	0.0	21.4	16.7	0.0	0.0
Chemical	N	1	1	8	10	12	1
	%	33.3	20.0	57.1	83.3	100.0	100.0
Atresia	N	0	2	0	0	0	0
	%	0.0	40.0	0.0	0.0	0.0	0.0

Foreign body	N	0	1	0	0	0	0
(Button battery)	%	0.0	20.0	0.0	0.0	0.0	0.0
Eosinophilic	N	0	1	3	0	0	0
	%	0.0	20.0	21.4	0.0	0.0	0.0

P value 0.001* statistically significant.

DISCUSSION

Esophageal strictures, often resulting from congenital anomalies, caustic ingestion, or postoperative complications, can significantly impair quality of life by causing dysphagia, malnutrition, and growth retardation. EBD has emerged as minimally invasive and effective therapeutic option for managing esophageal strictures in pediatric patients. This study has evaluated, efficacy and outcomes of EBD in children with esophageal strictures.

We have studied 47 patients and mean age calculated was 5.78 ± 3.29 years, with more males (57%) than females (43%). Most common cause of stricture found to be chemical burn 70.2%, followed by other etiologies. Stricture site found to be middle in majority (72.3%), followed by proximal (21.3%) and distal (6.4%). Length of stricture found to be <2 cm in 51% patients, 2-5cm in 43% patients and >5 cm in only 6% patients. Weight of patients before and at 4 weeks follow up calculated was 15.95 ± 6.76kgs and 17.19 ± 6.90 kgs, respectively.

Varying demographic trends were seen in previous studies. Study on children with eosinophilic esophagitis, found mean age of patients with esophageal strictures 12.7 years, higher than our observation.[15] However, one investigation revealed mean age similar to our study, 5.1 years, with underlying causes including achalasia 45%, esophageal atresia and caustic ingestion-induced stenosis 19% each and congenital cause found in 16%.[16] Furthermore, study examining endoscopic dilatation for pediatric esophageal strictures reported median patient age of 8.1 years, with contributing factors such as tracheoesophageal fistula 32.6%, GERD 23.3%, and eosinophilic esophagitis 18.6%.[17] Supporting our results, males accounted for 54.3% with esophageal strictures in previous study.[18] In contrast, another investigation found more girls 59.09%.[19] Likewise our study, previous studies found that majority of patients (78.9%) had strictures measured less than 5 cm in length and in one study 2-5 cm stricture length found in 65.6%.[20,21]

In our study, treatment response noted to be complete in 72.3% patients and symptomatic relief observed in 87% patients. According to one previous study dysphagia was alleviated in 60.5% patients, lower than our observation of 87%, and recurrence of symptoms was found in 31.6%, requiring next EBD session.[20] In addition to verified increases in weight-for-age, another investigation found 72% response for EBD.[14] One study found 98.8% success rate, 69.2% had complete response to dilatation, 26.9% showed good response, and 3.9% showed inadequate reaction. Even for those whose results were excellent, dilatations were still necessary because of their symptoms, similar to our observation.[21] In present study most patients requiring additional EBD had chemical etiology. In contrast another study reported, that overall outcome of all procedures was favorable in 62.5% of cases, however, no significant correlation between the outcomes and the causes, location of the strictures, or types of treatment.[22]

CONCLUSION

Our study found that EBD was effective in 87% of patients in terms of symptomatic relief. A complete initial treatment response was documented in 72.3% of patients. Patients with a chemical etiology required the highest number of EBD sessions. Therefore, EBD is a beneficial intervention for symptom relief and is successful in achieving a complete and long-lasting therapeutic response.

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Author's Contribution

IZ: Proposed topic, basic study design, material and methods and manuscript writing
AS: Data collection, statistical analysis and interpretation of result etc.
MAA: Literature review & referencing and quality insurer
MNA: Data collection and analysis
ZY: Data collection and Literature review
SSBH: Material and methods, data collection
All the authors have approved the final manuscript draft and accept the responsibility of research integrity.