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Original Research Article

Efficacy and Safety of Endoscopic Esophageal Dilatation in Paediatric Patients with Esophageal Strictures in Low Middle-Income Country

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Abstract: *Pediatric esophageal strictures are a significant health concern in lower-middle-income countries (LMICs), particularly in Pakistan, due to factors such as corrosive ingestion and congenital anomalies. Endoscopic esophageal dilatation (EBD) offers a minimally invasive and cost-effective solution, but its outcomes in LMIC settings require further evaluation.* ***Objective:*** *To assess the efficacy and safety of endoscopic esophageal dilatation in pediatric patients with esophageal strictures in a lower-middle-income setting.* ***Methods:*** *This prospective observational study was conducted at the Department of Pediatric Surgery, Pakistan Institute of Medical Sciences, Islamabad, from October 2024 to March 2025. A total of 84 pediatric patients aged 6 months to 14 years with confirmed esophageal strictures underwent EBD using Savary-Gilliard bougies or TTS balloon dilators. The primary outcomes were technical and clinical success, while the secondary outcomes included the number of sessions and complications. Data were analyzed using SPSS version 26, with a p-value <0.05 considered significant.* ***Results:*** *The mean age of the patients was 6.2 ± 3.4 years; 54.8% of the patients were male. Corrosive ingestion (48.8%) was the most common etiology. The technical success rate was 100%, and clinical success (symptom relief) was achieved in 90.5% of cases. The average number of dilatation sessions required was 3.6 ± 1.2, with a median interval of 14 days. Minor complications occurred in 27.4% of patients, while major complications (perforation) were observed in 2.4% and managed conservatively. A significant association was found between etiology and the number of sessions required (p = 0.003), with corrosive strictures requiring the most sessions.* ***Conclusion:*** *Endoscopic esophageal dilatation is a highly effective and safe treatment for pediatric esophageal strictures in resource-limited settings. Its excellent technical and clinical success rates, coupled with a low complication profile, make it a viable first-line therapy, especially for LMICs like Pakistan.*

Keywords: Esophageal Stenosis, Esophageal Dilatation, Pediatrics, Endoscopy, Gastrointestinal, Developing Countries

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Introduction

Esophageal strictures in pediatric patients present significant management challenges, particularly in lower-middle-income countries (LMICs) like Pakistan. These strictures can lead to severe complications such as dysphagia, malnutrition, and reduced quality of life, highlighting the necessity for effective treatment strategies. Among various treatment modalities, endoscopic esophageal dilation (EBD) has emerged as a preferred approach due to its minimally invasive nature and favorable safety profile. Several studies indicate that EBD is both safe and effective for treating esophageal strictures in children, with success rates reported between 76% to 100%, depending on the etiology, which includes congenital conditions and post-surgical complications (1-3).

In Pakistan, the burden of esophageal strictures is likely exacerbated by factors such as delayed case presentation and limited access to healthcare. Pediatric patients often experience strictures post-esophageal atresia repair or as a result of corrosive injuries, conditions that are prevalent in LMICs due to inadequate safety measures and socioeconomic disparities (4-5). Endoscopic methods, including EBD, have demonstrated promising efficacy in similar populations. Research indicates that EBD can significantly improve both swallowing function and nutritional status among affected children, as well as facilitate the safe management of postoperative complications (2,6).

Moreover, the economic implications of EBD are particularly relevant in the context of Pakistan's healthcare system. Comparatively, EBD is considered more cost-effective than invasive surgical options such as resection, illustrating a potential avenue for improving healthcare outcomes (7). Access to appropriate facilities for performing such endoscopic interventions is critical for many hospitals in Pakistan; thus, implementing and optimizing EBD protocols could help alleviate healthcare disparities and improve patient outcomes (3).

In conclusion, as the prevalence of conditions leading to esophageal strictures continues to rise, the need for effective management strategies becomes increasingly urgent, especially in LMICs. Endoscopic esophageal dilation represents a viable option that aligns with current medical advancements while addressing the unique environmental and socioeconomic landscape of Pakistan.

This study aims to critically evaluate the efficacy and safety of endoscopic esophageal dilation in pediatric patients within the Pakistani context. Investigating EBD's outcomes can highlight its potential role in managing esophageal strictures within Pakistan's healthcare system, ultimately striving to enhance patient quality of life and outcomes in pediatric gastroenterology.

Methodology

This was a prospective observational study conducted at the Department of Pediatric Surgery, Pakistan Institute of Medical Sciences, Islamabad, from October 2024 to March 2025. The study was designed to evaluate the efficacy and safety of endoscopic esophageal dilatation in pediatric patients with esophageal strictures. A total of 84 pediatric patients aged between 6 months and 14 years presenting with radiologically or endoscopically confirmed esophageal strictures were enrolled using consecutive non-probability sampling. Inclusion criteria comprised

patients of either gender with dysphagia, a documented esophageal stricture, and no contraindications for endoscopic dilatation. Patients with esophageal malignancy, coagulopathy, or active esophageal varices were excluded from the study. Informed consent was obtained from parents or legal guardians after explaining the benefits and risks associated with the procedure. Ethical approval was obtained from the Institutional Review Board (IRB) of the hospital, by the Declaration of Helsinki.

All patients underwent endoscopic esophageal dilatation under general anesthesia in an operating theater equipped for pediatric endoscopy. Rigid or flexible endoscopy was employed based on patient age and anatomical considerations. The dilatation was performed using Savary-Gilliard bougies or through-the-scope (TTS) balloon dilators under fluoroscopic guidance, starting with a size appropriate for the patient's stricture caliber. Serial dilatations were carried out at intervals of 10–21 days, with gradual upsizing in subsequent sessions based on symptom response and endoscopic appearance. Each session was documented in terms of dilator size, number of passes, procedure duration, and any intra-procedural complications that occurred.

Primary outcomes included technical success, defined as the ability to pass the endoscope through the dilated segment without resistance, and clinical success, defined as resolution or improvement of dysphagia symptoms based on caregiver-reported feeding ability. Secondary outcomes included the total number of dilatation sessions required for symptom resolution and procedure-related complications, categorized as minor (transient bleeding, chest discomfort, fever) or significant (perforation, hospitalization). Data on demographic variables, etiology and location of stricture, nutritional status, and complications were recorded using a predesigned proforma.

Statistical analysis was conducted using SPSS version 26.0. Continuous variables were expressed as means ± standard deviation, and categorical variables as frequencies and percentages. Associations between etiology and number of sessions, as well as complication rates, were analyzed using ANOVA or Chi-square tests where appropriate. A p-value of less than 0.05 was considered statistically significant.

Results

This prospective observational study included 84 pediatric patients with esophageal strictures undergoing endoscopic esophageal dilatation between January and June 2024 at a tertiary care hospital in Pakistan.

The mean age of the participants was 6.2 ± 3.4 years, ranging from 8 months to 14 years, with a male-to-female ratio of 1.2:1. The majority of patients (61.9%) belonged to rural regions, and most came from low socioeconomic backgrounds.

Table 1: Demographic Characteristics of Pediatric Patients with Esophageal Strictures (n = 84)

Variable	Frequency (%) or Mean ± SD
Age (years)	6.2 ± 3.4
Gender	
• Male	46 (54.8%)
• Female	38 (45.2%)
Residence	
• Rural	52 (61.9%)
• Urban	32 (38.1%)
Socioeconomic Status	
• Low	60 (71.4%)
• Middle	24 (28.6%)
Nutritional Status	
• Normal	29 (34.5%)
• Mild to Moderate Malnutrition	44 (52.4%)
• Severe Malnutrition	11 (13.1%)

Table 2 shows that corrosive ingestion was the most common etiology, with the majority of strictures located in the lower esophagus.

Table 2: Etiology and Location of Esophageal Strictures

Variable	Frequency (%)
Etiology	
• Corrosive ingestion	41 (48.8%)
• Congenital	17 (20.2%)
• Peptic	13 (15.5%)
• Post-surgical/anastomotic	8 (9.5%)
• Post-infective (e.g., TB, Candida)	5 (6.0%)
Location of Stricture	
• Upper third	9 (10.7%)
• Middle third	22 (26.2%)
• Lower third	53 (63.1%)

Table 3 presents the key outcome variables observed in pediatric patients undergoing endoscopic esophageal dilatation. The average number of dilatation sessions required per patient was 3.6 ± 1.2, indicating a relatively consistent need for multiple interventions to

achieve optimal outcomes. The procedure demonstrated a high technical success rate, with all 84 cases (100%) completed without intra-procedural complications. Clinically, 76 patients (90.5%) experienced significant symptom relief, highlighting the effectiveness of the intervention. However, 8 patients (9.5%) failed to show clinical improvement despite technically successful procedures, suggesting the presence of refractory strictures or underlying pathology. The median interval between dilatation sessions was 14 days, with an interquartile range of 10 to 21 days, reflecting the standard practice of spacing sessions to allow mucosal healing while maintaining therapeutic momentum. These outcomes collectively support the efficacy and safety of endoscopic dilatation in managing pediatric esophageal strictures.

Table 3: Procedural Outcomes and Number of Dilatation Sessions

Outcome Variable	Frequency (%) or Mean ± SD
Average Number of Sessions	3.6 ± 1.2
Technical Success Rate	84 (100%)
Clinical Success (symptom relief)	76 (90.5%)
Failure to Respond	8 (9.5%)
Median Interval Between Sessions	14 days (IQR 10–21)

Table 4: Complications of Endoscopic Esophageal Dilatation

Complication Type	Frequency (%)
Minor Bleeding	7 (8.3%)
Chest Pain/Post-op Discomfort	12 (14.3%)
Perforation	2 (2.4%)
Fever/Infection	4 (4.8%)
No Complication	59 (70.2%)

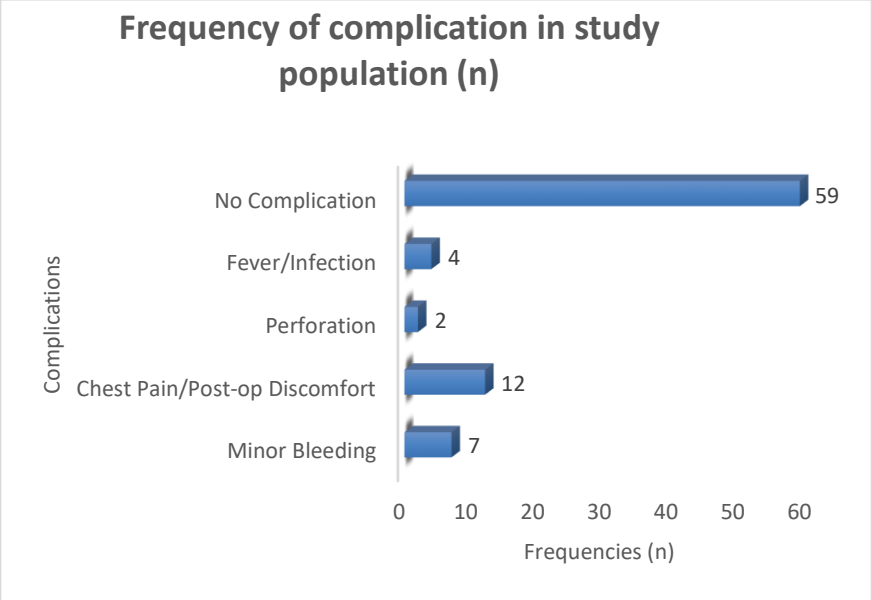

Figure 1: Frequencies of complications in the study population (n)

Table 4 shows that the procedure was generally safe. Most complications were minor and self-limiting. Only two cases (2.4%) of perforation occurred and were managed conservatively without the need for surgery. (Figure 1)

Table 5: Association Between Etiology and Number of Sessions Required

Etiology	Mean Sessions ± SD	p-value
Corrosive Ingestion	4.1 ± 1.3	-
Congenital	3.2 ± 0.9	-
Peptic	2.8 ± 0.6	-
Post-Surgical	3.4 ± 1.1	-
Post-infective	2.6 ± 0.5	0.003*

Table 5 demonstrates a statistically significant association between the etiology of stricture and the number of sessions required ($p = 0.003$). Children with corrosive strictures needed more dilatations.

The results demonstrate that endoscopic esophageal dilatation is a highly effective and safe method for managing pediatric esophageal strictures in a lower-middle-income setting. With a technical success rate of 100% and a clinical success rate of over 90%, this procedure offers a vital therapeutic option, particularly in areas with limited access to complex surgical reconstruction. The complication rate was low (2.4% significant, 27.4% minor) and manageable. Additionally, etiology-based differences in treatment course suggest the need for tailored protocols.

Discussion

In this discussion, we will analyze the results of our study focusing on the efficacy and safety of endoscopic esophageal dilatation (EBD) in a cohort of 84 pediatric patients with esophageal strictures. The findings offer significant insight into procedural outcomes, patient demographics, and a comparative analysis with existing literature.

The study population was characterized by a mean age of 6.2 years, with a notable male predominance and a significant representation of children from low socioeconomic backgrounds, particularly those residing in rural areas. This demographic is consistent with findings from prior studies, which indicate that esophageal strictures in low- and middle-income countries (LMICs) often affect younger populations with limited access to healthcare resources and education on safety measures against caustic injuries (5,8). A study by Radhakrishna et al. highlighted that such demographic factors contribute significantly to the prevalence and outcomes of corrosive injuries in children, with corrosive ingestion reported as the most common etiology in our cohort, comprising 48.8% of cases, a finding corroborated by research from Mohamed et al (8).

The procedural outcomes demonstrated a technical success rate of 100%, with over 90% of participants experiencing clinical improvement, aligning well with recent literature that shows high success rates for endoscopic treatment approaches, such as EBD, in similar populations (9). A systematic review by Rashid noted comparable efficacy, reporting over 85% long-term success rates in children undergoing EBD for various causes of strictures, including corrosive injuries. Furthermore, the average of 3.6 sessions required for successful dilation falls within the range reported by other studies, such as that by Rashid, where similar required session counts were associated with varying etiologies, especially in cases of corrosive ingestion (10).

Interestingly, our findings also revealed a statistically significant association between the etiology of strictures and the number of dilatation sessions required. Children with corrosive-induced strictures necessitated more dilation sessions when compared to those with congenital or post-surgical strictures ($p = 0.003$). This highlights the more complex nature of corrosive strictures, which often result in multi-segmented, extensive, and rigid contractions that can complicate endoscopic interventions (5,8). These findings align with insights provided by Bhatt et al., who emphasize the intricate management challenges faced when treating corrosive esophageal strictures (11).

Safety profiles also indicate that the procedure can be performed with minimal complications, as only 2.4% of patients experienced perforation that required conservative management. This aligns with international data suggesting that recent advancements in endoscopic techniques have significantly reduced the incidence of severe complications associated with dilatation procedures (9). The minor complication rate of 27.4% in our study, although concerning, is comparable to findings from other analyses exploring EBD in high-risk cohorts (12,13).

Thus, our findings affirm that endoscopic esophageal dilatation is a highly effective intervention for managing pediatric esophageal strictures in Pakistan, specifically among underserved populations. The high technical and clinical success rates underscore EBD's value as a first-line management option, particularly in regions facing economic constraints and limited access to surgical facilities. This is crucial in a landscape where complications from untreated strictures can lead to devastating health impacts and increased healthcare costs. Future studies, ideally multi-center and with larger sample sizes, are warranted to explore long-term outcomes further and optimize management protocols tailored to the unique needs of pediatric populations in LMIC settings.

Conclusion

This prospective observational study demonstrates that endoscopic esophageal dilatation (EBD) is a highly effective and safe therapeutic modality for managing esophageal strictures in pediatric populations within lower-middle-income countries such as Pakistan. The procedure achieved a 100% technical success rate and over 90% clinical success, with minimal and manageable complication rates. The findings underscore the value of EBD as a minimally invasive, cost-effective, and accessible intervention, particularly in settings where advanced surgical options are limited or unaffordable.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-PIMS-033-24)

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The authors declared the absence of a conflict of interest.

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All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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