

Dilation of Esophageal Strictures in Infants and Children: Single Institution Experience

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Abstract

Introduction: Esophageal strictures in childhood are typically benign and result from various factors like reflux esophagitis, caustic ingestions, and anastomotic scarring. Diagnosis is often by a barium esophagogram, with long strictures being over 2-3 cm. Initial management involves dilation using a balloon dilator or bougies, with balloon dilation gradually expanding the stricture to prevent mucosal injury. Despite the extensive history of esophageal dilation practices in Ethiopia, there remains a notable gap in the literature regarding pediatric esophageal stricture dilation and its associated procedural outcomes.

Objective: To assess outcome of esophageal dilation of a stricture in children over the past 10 years at Tikur Anbessa Specialized Hospital.

Methodology: Quantitative retrospective descriptive case series in 13 patients who underwent esophageal dilation from April 1, 2014 to March 31, 2024.

Result: Eight out of 13 patients (81% were male) had a median age of 2 years and 10 months, and all of them had dysphagia with the median duration of illness of 6 months. Twenty-three percent of them caused by congenital, post-esophageal foreign body removal, and post-surgery esophageal stricture. 61% (8/13) had a barium swallow diagnosis. Of the 13 (92%) had only single and short stricture. Forty percent of strictures occur in the distal portion of the esophagus. Three patients (23%) underweight and needed a gastrostomy. Bougie dilation done with median of two times per patient. For most patients (69%), the follow-up period was less than six months. Complete response seen in 46% (6/13) of instances following a single dilation session. Overall success rate was 69% (9/13).

Conclusion: The study examined esophageal strictures in children aged 1.5-12 years, with most having dysphagia. The majority had a single stricture, with the distal third being the most common. Bougie dilation was the primary treatment, with an overall response rate of 69%. The study suggests bougie dilation as a viable alternative for resource-limited settings.

Introduction

Esophageal strictures in childhood are nearly always benign, and arise from a variety of insults to the esophagus. The most common causes of esophageal strictures are reflux esophagitis, caustic ingestions, and anastomotic scarring. These are not mutually exclusive as repeated chemical insults to the esophageal mucosa from Gastro-Esophageal Reflux may aggravate anastomotic and corrosive strictures. Strictures typically diagnosed with a barium esophagogram. Strictures greater than 2–3 cm in length characterized as long strictures. Anastomotic strictures tend to be discrete and short, whereas corrosive strictures are more likely to be irregular and long. Peptic esophageal strictures are usually short and located in the lower third of the esophagus [1].

The central component of initial management of an esophageal stricture is dilation, either with a balloon dilator or semirigid Savary–Gilliard bougies. Dilation performed over a guide wire under fluoroscopy or under direct endoscopic vision. Typical initial treatment of strictures consists of balloon catheter dilation with aggressive medical management of the GER. The theoretical advantage of balloon dilation over bougienage is that the stricture is gradually dilated by a uniform radial force, whereas bougienage exerts an abrupt shearing force that may cause injury to the mucosa and lead to further scarring and stricture.

The balloon slowly inflated with contrast medium, allowing a fluoroscopic view of the “hourglass” or require several dilations over several months for radiographic resolution. The interval between dilation sessions individualized but averages 2–4 weeks. The number of required dilation sessions is highly variable, ranging from 1 to 37 in two recent series [3].

Most patients have complete resolution of the stricture and associated GER with this management strategy. Adjunctive treatment options that may increase the success of dilation include injection of steroids or mitomycin C into the stricture [5, 6] Use of covered stents to maintain esophageal patency after dilation described in children, but limited to small case series [7]. The perforation rate with balloon dilation is <2% in most series, but may be as high as 10%. Dilation-related perforations usually successfully managed nonoperatively [1, 3, 8]. Strategies to help prevent perforation include accurate preoperative characterization of the stricture morphology; general anesthesia; fluoroscopic guidance, ensuring the guide wire always remains in the correct position; choosing a balloon/bouginage size that is not greater than the size of the patient’s esophagus; not overinflating the balloon; and gradually increasing the size of the balloon/bouginage over several sessions.

Significance of the Study

Esophageal stricture has historically been treated by esophageal dilation involving bougie and balloon techniques of various kinds, with balloon dilation demonstrating superior outcomes due to its application of radial force as opposed to the shearing longitudinal force applied by bougie dilation methods. The longstanding practice of esophageal dilation observed in Ethiopia over the course of the past few decades, where the procedure has commonly involved the utilization of both flexible and rigid bougie dilators under the guidance of rigid endoscopy. Typically conducted on an outpatient basis, the procedure has often required the administration of general anesthesia to ensure patient comfort and safety.

Despite the extensive history of esophageal dilation practices in Ethiopia, there remains a notable gap in the literature regarding pediatric esophageal stricture dilation and its associated procedural outcomes, necessitating further investigation to identify potential enhancements that could be made to the service. There is no published or unpublished study done on the esophageal dilation procedure done for children prior to this study to comment on whether we are doing the procedure as to the rest of the world does or not. Additionally, we were only able to find few articles who were majorly reported their findings on bougie dilation eliciting the fact that in LMIC like Ethiopia where the only bougie dilation is being practiced, We hope that this study will bring more information of the procedure in to light. This series will be one of its kind which will act as a benchmark for further studies.

The forthcoming study will serve as a preliminary exploration into this uncharted territory, aiming to lay the groundwork for future research endeavors in this area. By shedding light on the efficacy and safety of pediatric esophageal stricture dilation tech-

niques, this pilot study seeks to contribute valuable insights that can inform and potentially transform clinical practices in the field. Through a meticulous examination of the outcomes and complications associated with the procedure, this research initiative aspires to advance the standard of care for pediatric patients suffering from esophageal strictures. Furthermore, the findings of this study may pave the way for the development of tailored protocols and guidelines that specifically tailored to address the unique needs and challenges associated with pediatric esophageal dilation procedures.

Objectives of the study

General Objective

- Assess the outcome of esophageal dilation done for esophageal stricture in Tikur Anbessa Specialized Hospital from April 1, 2014 to March 31, 2024

Specific objectives

- Assess socio demographic status and presenting symptoms of patients who undergone esophageal dilation in the study period.
- Determine cause, frequency and site esophageal stricture of patients who undergone esophageal dilation in the study period.
- Assess techniques, frequency, and interval of dilation of patients who undergone esophageal dilation in the study period
- Identify outcome of esophageal dilation of patients with stricture in the study period.

Operational Terms

Complete Response: absent dysphagia reported by the mother after the 2x dilation sessions

Inadequate response: Residual dysphagia reported by the mother after the 2x dilation sessions

Failure of dilation:/refractory - No change in dysphagia reported by the mother after the 2-5 session of dilation with 2weeks interval.

Recurrence- dysphagia coming back after 1 month of complete response.

Conservative management: Supportive care with antibiotic, antipain, and Feeding Gastrostomy

Outcome of dilation- response, perforation, death

Methodology

Study design

Quantitative retrospective descriptive case series.

Study Area

The study conducted at Tikur Anbessa Specialized Teaching Hospital (TASH), Addis Ababa University, College of Health Sciences, Department of Surgery, Division of Pediatric Surgery, where a full time pediatric Surgical services given.

Study Period

The study included all esophageal dilation procedures done over the past 10 years (from April 2014 to March 31, 2024)

Source Population

All children who had esophageal stricture in the study period.

Study population

All children with esophageal stricture who underwent esophageal dilation.

Inclusion criteria: All children younger than 15 years of age with esophageal stricture who underwent dilation in the study period at TASH

Exclusion criteria: children whose records are lost are excluded from the series.

Study Variables

Independent variables: Age, sex, presenting symptoms, duration, etiology, diagnosis, Site and length of stricture, pre-procedure feeding tube, type of dilation, number of dilations, interval between dilation, size of dilator, diagnosis of complication, recurrence, interval to recurrence, duration of follow up, management of complication, post procedure Feeding Gastrostomy (FG).

Dependent variable: response, perforation, death.

Data Collection

Patient data collected using structured and pretested checklist. Data collection done by trained data collectors.

Quality Assurance

Data checked for completeness and cross checked for accuracy. Defective questions containing inadequate data rechecked and the inadequate data rejected and all the checklist and document kept properly for possible checking.

Ethical Considerations

The ethical clearance for the study obtained from AAU College of Health sciences ethical review board and written permission from TASH administrator. The data kept confidential and used for research purpose only.

Literature Review

Retrospective series done in France focused on a group of 49 young patients, who underwent balloon dilation for esophageal stricture between April 2002 and August 2009. The follow-up period after the treatment varied from 20 to 109 months, with an average of 40 months. Each patient underwent a maximum of three dilations per procedure. A minimum interval of 3 weeks was maintained between two consecutive procedures. The success of the treatment was determined by the reduction or complete disappearance of dysphagia and the satisfactory weight gain observed during the follow-up period. The patients included in the study ranged in age from 3 weeks to 14 and half years, with an average age of 20 months. The majority of the patients were male (55%). The most common causes of esophageal stricture were esophageal atresia (49%), corrosive injury (25%), and epidermolysis bullosa (14%). Other less common causes made up the remaining 12%. The most common symptoms reported by the patients were dysphagia (100%), vomiting (45%), and excessive salivation (37%). The stricture was found to affect two-third of the patients at a single level, while the remaining third had multiple levels of stenosis. The lower third of the esophagus was

the most frequently affected region (37%), followed by the middle (34%) and the upper 3rd (29%). Prior to the procedure, Third of the patients had a gastrostomy and nearly 70% were on anti-reflux medication. In total, 138 dilation sessions were conducted, with each patient undergoing between 1 and 8 sessions. The size of the balloon used during the first session ranged from 6 mm to 15 mm, while during the final session, it ranged from 8 mm to 18 mm. The success rate of the treatment was 86%, with 12% of the patients requiring additional surgery to address residual stenosis. Three cases of esophageal perforation were observed, accounting for 6% of the patients or 2% of the procedures. However, all perforations healed without further intervention [9]

Between July 1984 and December 2002, a total of 77 patients with esophageal strictures were treated in 3 centers consecutively (33 in Royal Liverpool Children's Hospital, Alder Hey, UK; 19 in John Radcliffe Hospital, Oxford, UK; and 25 in Queen Mary Hospital, Hong Kong). All children suspected of having esophageal stricture with symptoms of excessive drooling, regurgitation of food substance, decreasing tolerance of the caliber of food particles, or dysphagia were assessed with a contrast study to evaluate the location and diameter of the stricture. Flexible upper gastrointestinal endoscopy and balloon dilation was performed under GA. Age range was 2 months to 20 years; all except 3 were less than 6 years old. The indications were stricture after repair of esophageal atresia (81%), reflux esophagitis (9%), tight fundoplication (2.5%), caustic injury (3.8%), and achalasia (2.5%). Over the 17 years of review, these 77 patients underwent 260 dilatations. The mean number of Endoscopic Balloon Dilation (EBD) per patient was 3.4 (range, 1 to 19) over a maximum of 28 months (median, 5 months) for a satisfactory result. 15% needed only one procedure for effective relief of symptoms. four complications of perforation (1.5%) were observed owing to overenthusiastic dilatation. The primary diagnosis of these patients with perforation was caustic stricture (75%) and esophageal atresia with primary repair (25%). only one patient requiring surgical repair. A contrast study was performed on day 10 to exclude the presence of leakage. All four were symptom free during follow-up and did not require further dilatations. Overall, successful outcome was seen in 97%. During long-term follow-up (median, 6.6 years), all patients who initially had successful outcomes continued to be symptom free with a good quality of life [10].

46 children were found to have esophageal strictures in a study done in Bahrain 2021. There were 25 males (54.3%) and 21 females (45.7%). Most patients presented during infancy (86.5%). All patients were symptomatic and had evidence of esophageal stricture in the contrast study. Twenty-six (56.5%) patients required esophageal dilatations with a total of 88 dilatation sessions. dilator was used in 21 (80.8%) patients. post EA/TEF repair anastomotic stricture was the main cause of esophageal strictures and was found in 35 (76.1%) of the patients. The cause of esophageal stricture was anastomotic stricture in 16 (61.5%) patients requiring dilatation and 19 (95%) patients who did not require dilatation. On the other hand, other causes such as GERD, post-corrosive ingestion, and epidermolysis bullosa were found only in patients who required dilatations. Out of the 46 patients, 35 (76%) patients had available data about the site of strictures, 26 (74.3%) had upper strictures, eight (22.9%) patients had middle strictures, and one (2.8%) had distal stricture. It was reported that the median number of dilatations per patient was 3, with a range of 1 to 8 dilatations per patient. Patients with no anastomotic strictures had more frequent dilatations (10 patients required 39 dilatations, mean \pm SD = 4 ± 3) compared to patients with anastomotic strictures (16 patients required 49 dilatations, mean \pm SD = 1 ± 2) ($P = 0.007$). The primary efficacy of the procedure was 98.8% (87 out of 88 dilatations). Complete response was found in 18 (69.2%) patients, satisfactory response in seven (26.9%), and an inadequate response in one (3.9%) patient. Seven (26.9%) patients still require ongoing dilatations. On follow-up, 12 of the 16 patients who underwent EA/TEF surgery and dilatations achieved complete response the median follow-up period was six years. There was no esophageal perforation or mortality during endoscopic dilatation [11].

In a retrospective study done in turkey in 2022, they reviewed the medical records of children who underwent fluoroscopy-guided esophageal balloon dilatation for treatment of benign esophageal stricture from February 2008 to July 2019. Technically successful procedures included 375 balloon dilatations in 116 patients (67 boys; age range: 1 month to 18 years; mean age: 4.3 ± 4.8 standard deviation [SD] years at the initial dilatation). The follow-up period was 1–138 months (median: 41 months; mean: 44 months) since the last dilatation. in the same study, the clinical success rate was 34% per procedure (120 of 353 procedures) and 85% per patients (91 of 107 patients). The total complication rate per procedure was 0.5%, and the perforation rate

was 0.25% per session [12].

In a retrospective chart review conducted in South Africa in 2017, 39 patients were identified with esophageal stricture ages ranging from one month to 13 years, and there were 18 (46%) males and 21 (54%) females. Most participants were black South Africans 36 (92%). Strictures secondary to surgical correction of esophageal atresia 14 (35.9%) were the most common, followed by due to corrosive injury 12 (30.8%). HIV-related strictures were seen in 8 (21%) children, while gastro-esophageal reflux 2 (5%), and foreign body (FB) ingestion in 3 (7.6%) were less common. The most common stricture site was the middle third of the esophagus (51%), with 33.3% in the upper-third and 16% in the lower-third. Most of the patients had a single stricture 36 (92%). Strictures secondary to acid ingestion were common in the upper- and middle-third of the esophagus, and those following alkali ingestion occurred in the lower-third of the esophagus. Dysphagia was reported by 32 patients (82%) on presentation. Seven (18%) patients reported no dysphagia, of whom five were treated for esophageal atresia and were still breastfeeding. Contrast esophagograms were used in the diagnosis and in the follow-up of most patients (32 (82%)). The mean duration of treatment per patient was 29.5 months. Overall, 287 dilatations were performed in 39 patients the median (interquartile range (IQR)) number of dilatations per patient was highest for those with acid- and alkali-related injuries (10 (5 - 14) and 6.5 (5 - 10), respectively), and lowest for those related to FB ingestion (2.5 (2 - 3)). Perforation occurred in 8 (3.1%) cases, out of 287 attempted dilatations. Over a 3-year follow-up period, recurrence of the OS was observed in 12 (32.4%) patients and was most frequent following alkali ingestion (50%). Mitomycin C was applied locally in 4 (10.3%) patients with a mean (standard deviation (SD)) of 8.7 (2.8) applications per patient. Mitomycin C application was associated with stricture resolution in all patients. Stenting was performed in 2 (5.1%) patients: Esophageal replacement was performed for 3 (7.6%) patients following caustic injury. Five (13%) patients died: two following perforations, including the HIV-infected patient who underwent esophageal stenting; one following surgical replacement of the esophagus; and two from unrelated sepsis. Seven (18%) patients were lost to follow up, and three (8%) were referred to general surgeons for follow-up [13].

A report of 8.5 years' experience with bougie dilation in 111 Indian children was done in 2001.. Dilation was successful in 104 patients (93.7%); 3 required surgeries (as primary treatment in 2 and after perforation in 1). The mean age of the 107 children was 4.8 ± 3.4 years (1 month to 14 years); the M:F ratio was 3:1. Mean follow-up was 16 months (range 1 to 99 months). Commonest etiology was corrosive ingestion in 49%, followed by sclerotherapy induced 21%, after surgery 13 %, congenital 9%, peptic in 3.5 %. All of the children presented with dysphagia and vomiting; the mean duration of symptoms was 10.4 months (range 1 month to 8 years). A feeding jejunostomy had been established in 6 children before dilation. Almost half the children had corrosive strictures. The corrosives ingested were acid in 34 and alkali in 20. Among the patients with corrosive strictures, dilation was successful in 52 (96%). Among patients with short strictures, 3 did not require further "as needed" dilations after initial successful dilation, whereas all children with long and/or multiple strictures required further "as needed" dilations. Successful dilation was possible in all but 1 of the children with noncorrosive strictures (98%). Dilation was considered adequate if the esophageal lumen could be dilated to 15 mm. Six perforations occurred during 648 dilation sessions (0.9%). Five of the patients had corrosive strictures and 1 had a congenital stricture. One child required surgery; the rest had contained perforations that were managed conservatively and subsequently, dilations were continued as per schedule. There was no death [14].

In a prospective cross-sectional study performed during one year (2016 - 2017), at the Children's Medical Center Hospital in Tehran (Iran). Children under 16 years with benign esophageal stricture were enrolled. Between May 2016 and June 2017, 31 children with ES were referred for endoscopy. Sixty one percent (n = 19) of them were male. The mean age was 5.1 ± 3.9 years (range: 1 - 15 years). The most common causes of esophageal stricture were achalasia (45%), esophageal atresia (19%), caustic ingestion (19%) and congenital stenosis (16%) respectively. Congenital stenosis, esophageal atresia, and achalasia were more common in boys. The frequency of stenosis due to caustic ingestion was the same in both genders. There were no complications following the EBD. A total of 64 dilatation procedures were performed. Some patients needed more than one procedure. The frequency of balloon dilatation was as follows for each patient: 1, 2-, 3-, 4-, and 5-times dilatation were performed in 15 (48.4%), 8 (25.8%), one (3.2%), 5 (16.1%) and 2 (6.5%) patients, respectively. According to this data, only one session was effective in 48.4% of children. Overall, in 23 (74.2%) patients, clinical problems were resolved with 1 - 2 times dilatation. A total of

87.1% children (n = 27) had a good response to treatment. Resistance to treatment or recurrence of the stricture was more common in patients with stenosis due to caustic ingestion. A total of 4 patients (12.9%) had a treatment failure and were referred for surgery [15].

Retrospective observational study was conducted on 259 children in India with esophageal strictures managed between June 1994 and March 2020. All children younger than 18 years with esophageal strictures were included in the study. comparative analysis of bougie versus balloon dilatation was performed on 77 children where either an bougie (n Z 54) or balloon (n Z 23) dilatation was used exclusively for short strictures. The median age of 259 children with symptomatic esophageal strictures was 2.5 years (IQR, 1.1-5.5), with a male-to female ratio of 2.2:1. Among them, 188 had a single, short esophageal stricture in which an exclusive bougie or balloon dilatation was performed in 77. As expected, all children presented with dysphagia. Vomiting was seen in 163 of 207 patients (78.74%), respiratory issues in 48 of 199 (24.1%), and failure to thrive in 109 of 196 (57.40%). Among the etiology of strictures, the most common was anastomotic (99 [38.2%]), closely followed by corrosive (96 [37.1%]), peptic (26 [10%]), congenital 19 (7.3%), Post-endoscopic sclerotherapy 13 (5%), and other 6 (2.3%). Among the anastomotic strictures, 96 were after esophageal atresia repair and three were after surgery for esophageal perforation. In the corrosive group, acid ingestion was responsible for 49 strictures, alkali for 34, and the remaining 13 were unknown. The outcome was analyzed for 186 cases; dilatation was successful in 168, with an efficacy of 90.32%. Of the 18 unsuccessful cases, perforations occurred in 14 children, 2 children with unresolved strictures were continuing on dilatation at the time of the last follow-up, one child underwent a 2-staged colonic interposition, and another child was scheduled for esophageal replacement surgery for difficult stricture with failed dilatation. The perforation rate in the overall cohort for balloon dilatation was .51% (5/970) and that for bougie dilatation was .37% (6/1610), which was not significant (P = .595)

In the subgroup of 77 patients where an exclusive bougie or balloon dilatation was performed for short strictures, seven esophageal perforations (guidewire-related= 1; bougie= 3; balloon= 3) occurred over 1416 dilatation sessions. There was no significant difference (P Z .591) in the perforation rate for balloon (3/560 [.54%]) and bougie (3/856 [.35%]) dilatation for short strictures. Compared with the corrosive group (n Z 55), children with anastomotic strictures (n Z 76) presented at a younger age (P < .001) and required significantly fewer sessions to achieve adequate dilatation (P < .001). Also, the requirement for (P Z .003) and number of as-needed sessions (P Z .018) were significantly less in the anastomotic group. Comparison of anastomotic (n Z 42) and corrosive (n Z 18) strictures in the bougie alone group versus balloon alone group showed a younger age at presentation in the anastomotic group (median, .83 years vs 2.75 years, respectively; P < .001). However, there was no significant difference in the requirement of as-needed sessions (19.05% vs 38.89%, P Z .11) and median PDI (dilations per month) after adequate dilatation (.5 vs .5, P Z .30) among the 2 groups. Comparison of short versus long and/or multiple strictures Among the corrosive stricture group, a comparison of short versus long and/or multiple strictures showed a younger patient age at presentation among those with short strictures (median, 3 years [IQR, 2-3] vs 3.5 years [IQR, 2.50- 6]; P Z .04]. The median number of sessions to achieve adequate dilatation was significantly less in the group with a short stricture (for as-needed sessions in the group with long and/or multiple strictures (9/31 [29.03%] vs 20/24 [83.33%], P < .001). Feeding gastrostomy or jejunostomy was used for supplementing feeds in 3 of 168 children (all corrosive strictures) who underwent successful dilatation. A Soehendra biliary dilatation catheter was used in 36 cases (corrosive, 17; anastomotic, 13; congenital esophageal stenosis, 4; peptic, 1; other, 1) for the initial negotiation of a tight stricture [IQR, 5-13] vs 19 [IQR, 12.25-28.50], P,0.001) An increased requirement was found [16].

A case series from China done in 2013, 13 patients who had caustic esophageal stricture underwent endoscopic therapy. Mean period of follow up from the time of the last endoscopic therapy was 39 months (range 29–70 months) The patients consisted of seven males and six females with a mean age of 30.69 years (range 7–54 years). Three patients had a history of acid ingestion, six alkaline, and in four the agent was unknown All of the cases involved accidental ingestion except case 4 who drank 200 mL methyl ethyl ketone. Clinical manifestations included heartburn, chest pain, dysphagia, cough, abdominal pain, vomiting and hematemesis. Before dilatation, five patients received jejunostomy because of nutritional problems. Once endoscopic therapy began, the patients presented to the hospital every several weeks because of recurrent dysphagia. the mean interval was 37 days.

Stricture resolution was defined by the ability to swallow semi-solid or solid food and the absence of dysphagia for at least 24 months. Endoscopic therapy was successful in 92% of patients (12/13 patients), but unsuccessful in case 9. Of the successful patients, 7 required dilations only, whereas the other five patients received both dilations and stent implantation. The mean duration of stricture resolution was 15 months, with a range of 4–48 months. No complications such as infection, mediastinitis or perforation were observed during or after the dilation sessions. Also, the stents were all in the correct location before removal. The dwell time of esophageal stents was approximately 6 weeks [17].

A retrospective review of 369 EBD sessions using fluoroscopically guided EBD to treat 38 children with caustic ES between November 2004 and November 2012 at Turkey. Most cases occurred after strong alkali ingestion [31 (81%) alkali, six (16%) acid, and one (3%) unknown caustic substance], Follow-up was 4–96 months (median, 35 months). 61% were boys, median age- 3.5yrs (14mo – 14yrs) In 32 % of them there were 2 stricture, middle esophagus is the most affected (62%), followed by upper in 22 % and lower in 16%. 61 % is long stricture which is more than 1 vertebra wide/2 stricture ?? . EBD treatment was of significantly shorter duration for the early dilatation group (n = 16) than the late dilatation group (n = 11) .In addition, the short stricture (n = 12) treatment was also of significantly shorter duration than the long stricture (n = 15) treatment All EBD sessions were performed successfully in all patients. Mean procedure time between entry and exit from the operation room was 34.2 min (\pm standard deviation, 9.8; range, 9–75 min). Seven post-operative complications [six (1.6%) esophageal perforations in five patients (13.2%), one (0.2%) atelectasis in one patient (2.6%)] occurred. All perforations were treated conservatively (immediate nasojejunal feeding, antibiotics, tube thoracostomy if needed). Gastroesophageal reflux disease was diagnosed in eight patients by barium swallow study. These patients received anti-reflux medications (ranitidine or lansoprazole) until their ESs were treated. One patient who had intractable ES and severe gastroesophageal reflux disease underwent Nissen fundoplication. No mortality due to EBD occurred in the series. Neither gastrostomy nor esophageal replacement surgery, or intralesional steroid injection, was performed in any patient [18].

This single center prospective study was conducted in, Multan, Pakistan. Diagnosis of ES was made as preclinical history, endoscopy and findings from contrast-enhanced radiological examination of the esophagus out of 32 children, 19 (59.4%) were males and 13 (40.6%) were females. Age ranged from 1-15 years. Thirteen (40.62%) patients ranged in age from 1-3 years, 11 (34.38%) from 4-7 years, 6 (18.75%) from 8-11 years and 2 (6.25%) from 12-15 years. Mean age of the patients was 36.58 ± 19.6 months. Chemical burn (n=23; 71.9%), esophageal atresia (n=4; 12.5%) and gastroesophageal reflux disease (GERD) [n=2; 6.3%] were the most frequent cause of ES. Congenital, achalasia and foreign body were the causes in 1 (3.1%) case each. Out of 32 cases of ES, 24 (75%) had proximal and 8 (25%) had distal stricture. Among 23 cases of chemical burn, 18 (78.3%) had proximal involvement while 5 (21.7%) involved distal esophagus. All four cases of esophageal atresia had involvement of proximal esophagus. Out of 32 patients with ES, 10 (31.3%) underwent dilatation, one (3.1%) patient had surgery and 21 (65.6%) required both dilatation and surgery. In patients with chemical burns, majority (n=16/23; 69.6%) required both dilatation and surgery and 7 (30.4%) patients underwent dilatation only. Overall outcome of treatment options was good in 62.5% (n=20/32) patients, while 37.5% patients had no significant improvement with any treatment option. Out of 21 patients requiring both dilatation and surgery, outcome was good in 61.9% (n=13/21), while in patients having dilatation only, 70% (n=7/10) had improved outcome (p=0.385). Thoracotomy and esophagoplasty was done in one patient as end to-end anastomosis was not possible due to too short healthy esophagus. End to end anastomosis was done in 15 patients, all cured after surgery.

Pneumothorax occurred in one patient as complication during the process of dilatation which was managed by chest tube insertion and oxygen therapy, and patient improved. Outcome in patients with chemical burns was good in 69.6% (n=16/23) cases. Mortality was reported in 3.1% (n=1/32) of patients [19].

Results

Out of the 30 patients who underwent dilation procedure over the mentioned 10 years we have only found 13 medical records. Of all the cases 65 % (8/13) were male and age of the patients ranged from 1 and half years up to 12 years with median age be-

ing 2 years and 10 month as well mean age is 3 years and 10 month. 69 % (9) were younger than 3 years. All of our patients presented with dysphagia of variable degree with 38 % (5/13) had additionally vomiting of ingested matter as well. In our study the duration of illness ranges from 1 month to 7 years of dysphagia, median duration being 6 month. The mean duration of illness is 1 year and 2 month . 53% (7/13) had dysphagia for more than 6 month.

Table 1: Demographic and presentation of children who are presented with esophageal stricture to Tikur Anbessa specialized hospital Tikur Anbessa Specialized Hospital from April 1 2014 to March 31, 2024.

Age	Frequency	Percent
<2 yrs	3	23%
2-3 yrs	6	46%
>3 yrs	4	31%
Gender		
Male	8	61%
Female	5	39%
Duration of Illness		
< 6month	6	46%
>6month	7	54%
Total	13	100%

Coming to the diagnosis of esophageal stricture was made based off barium swallow in 61%(8/13) followed by UGE 23%(3/13). regarding to the etiology of esophageal stricture, congenital post-surgical and post foreign body swallow share equivalent frequency each contributing 23 % (3/13). 92%(12/13) had single and short stricture .most of the children had distal stricture , 40 % (5/13) . Of 13 children 3 patients needed feeding gastrostomy before any attempt at esophageal dilation.

Table 2: Etiology, diagnosis modality and site of stricture in children who presented with esophageal stricture to Tikur Anbessa Specialized Hospital from April 1 2014 to March 31, 2024

Etiology	Frequency	Percent
congenital esophageal	3	23%
post surgical	3	23%
post foreign body swallow	3	23%
Corrosive	2	15%
Other	1	7%
peptic stricture	1	7%
Total	13	100%
Diagnosis Modality		
Barium swallow	8	61%
UGE	3	23%
CT	2	16%
Total	13	100%
Site of Stricture		
Proximal third	4	30%

Middle third	4	30%
Distal third	5	40%
Total	13	100%

For all the patient for who we collected the record for has had undergone 30 dilation procedure done for 13 of the patients. Esophageal dilation with mercury weighted Malony bougie dilator was done . No patient underwent pneumatic balloon or guide wire directed dilation. Bougie dilation was done from once to 9x per patient the median being 2 times and the mean is 2.4 times. Most of our patient, 46 %(6/13), underwent dilation dilation twice while 38 %(5/13) underwent esophageal dilation once .

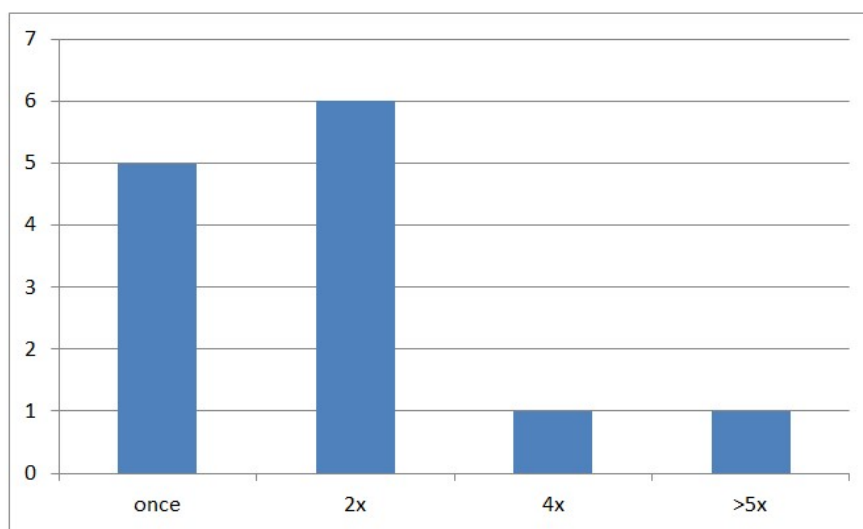


Figure 1: The frequency of esophageal dilation which was done for children who presented to Tikur Anbessa Specialized Hospital with diagnosis of Esophageal stricture from April 1,2014 to March 31, 2024

Interval between dilation sessions for each case was more than 2 weeks in 4/13 of the cases only for different reasons. Otherwise most of the cases were dilated within 2 weeks interval.

Sixty nine percent (9/13) of the children in our series had follow up for only less than 6 month after dilation for esophageal stricture

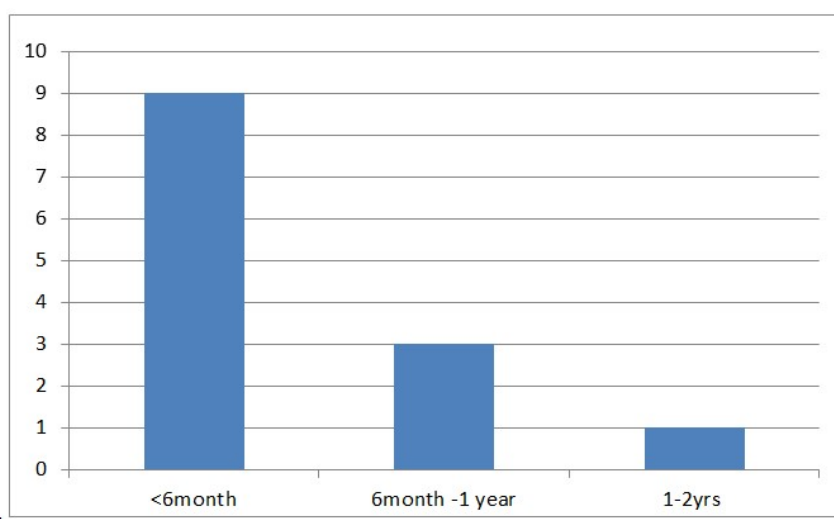


Figure 2: The duration of follow up for children who presented to Tikur Anbessa Specialized Hospital with diagnosis of Esophageal stricture April 1 , 2014 to March 31, 2024

The response after dilation was (6/13) 46 % had complete response after single dilation session. 9/13 patients were discharged improved with success rate of 69%.

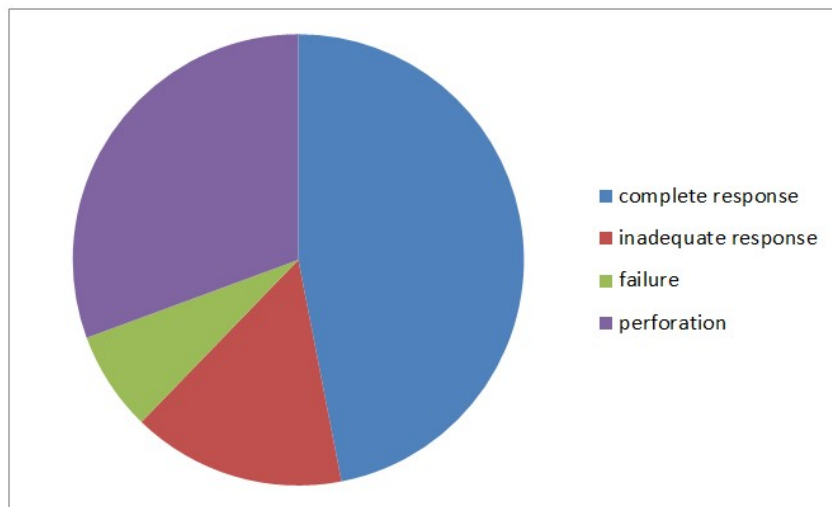


Figure 3: The response after esophageal dilation for children who presented to Tikur Anbessa Specialized Hospital with diagnosis of Esophageal stricture from April 1, 2014 to March 31, 2024

In our current series, 30% (4/13) perforation rate was observed. Among the 4 cases which perforated 3 of them were managed with feeding gastrostomy and chest tube. 2 of them improved and discharged and 2 of them died with mortality rate of the procedure of 6.6%. Half of the perforated cases had corrosive ingestion as a cause of esophageal stricture, 1 had congenital stricture the other one had post foreign body swallow esophageal stricture. From the followed patient (2/13) had recurrence within 3 months of the last procedure with a rate of 15%.

Discussion

In our study we have found limited number of records despite there were around 30 cases for whom dilation done over 10 years. Out of the 30 patients, only 13 documents were found.

Of the 13 cases, when we see the gender distribution, 61% (8/13) are male patient which is similar to the studies done different part of the world (55%) were male in France (9) 54.3% were male in Bahrain (11), the M:F ratio was 3:1 in Indian study (14), Sixty one percent of them were male in Iran (15), (59.4%) were males in Pakistan (19), but in South African study (13) 54% of them were females.

In our series, age of the patients ranged from 1 and half years up to 12 years with median age being 2 years and 10 month. And mean age is 3 years and 10 month. The other studies showed similarities in our review. In France (9) The patients included in the study ranged in age from 3 weeks to 14 and half years, with an mean age of 1 years and 8 months, in the study done at multiple center at UK and HK (10), the age range was 2 months to 20 years; in Turkish study (12); age range: 1 month to 18 years; mean age: 4.3 ± 4.8 standard deviation [SD] years. In the study done in South Africa (13) age range was from one month to 13 years. In Indian study (14), the mean age of the 107 children was 4.8 ± 3.4 years (1 month to 14 years). In Iran (15), the mean age was 5.1 ± 3.9 years (range: 1 - 15 years). In the study done in Multan, Pakistan, (19) age ranged from 1-15 years. Mean age of the patients was 36.58 ± 19.6 months

On the current series, Around 69% (9/13) of the cases were younger than 3 years of age on presentation while the study done in Bahrain [11] Most patients presented during infancy (86.5%).

All of the patients presented with dysphagia on swallowing with variable grade of dysphagia in this series. Thirty eight percent

(5/13) of the patients had vomiting of ingested matter in addition to the dysphagia on presentation. Similarly, in the French study (9) the most common symptoms reported by the patients were dysphagia (100%), vomiting (45%), and excessive salivation (37%). In South African audit (13), dysphagia was reported 82% on presentation while the rest reported no dysphagia, of which five were treated for esophageal atresia and were still breastfeeding. As well in India [14], all of the children presented with dysphagia and vomiting. In more recent Indian study [16] also all children presented with dysphagia. Vomiting was seen 78.74% 24.1%, and failure to thrive in 57.40% along with the dysphagia.

In our study the duration of illness ranges from 1 month to 7 years of dysphagia, median duration being 6 months. The mean duration of illness is 1 year and 2 months. Most of the patients 53% (7/13) came at and before 6 months of dysphagia while the study done in India [14] the mean duration of symptoms was 10.4 months (range 1 month to 8 years).

Regarding the etiology of the stricture, Congenital, post esophageal foreign body removal and post-surgery esophageal stricture shares equal distribution each being 23%. While in France (9) the most common stricture was post-surgery (49%) followed by post corrosive ingestion (25%). In the report done in 3 hospitals at UK and HK (10), the most common cause of stricture was stricture after repair of esophageal atresia (81%), followed by reflux esophagitis (9%), tight fundoplication (2.5%), caustic injury (3.8%), and achalasia (2.5%), whereas in Bahrain [11], post EA/TEF repair anastomotic stricture was the main cause of esophageal strictures which is 76.1% of the patients. In the study conducted in South Africa [13] Strictures secondary to surgical correction of esophageal atresia 35.9% were the most common, followed by due to corrosive injury 30.8%, in Indian study (14) the most common etiology was corrosive ingestion in 49%, followed by sclerotherapy induced 21%, after surgery 13%, congenital 9%, peptic in 3.5%. In a study done in Tehran, Iran (15), the most common causes of esophageal stricture were achalasia (45%), esophageal atresia (19%), caustic ingestion (19%) and congenital stenosis (16%) respectively. In Pakistan (19) Chemical burn (71.9%), esophageal atresia (12.5%) and gastroesophageal reflux disease (GERD) (6.3%) were the most frequent cause of ES.

In the current study 61% (8/13) of the diagnosis is made from a contrast study. Barium swallow was done on presentation and showed variable degree of stenosis. In UK and HK (10) as well in Bahrain study (11), barium swallow was used to diagnose all patients, in South Africa (13) Contrast esophagograms were used in the diagnosis (82%)

In our current study, 92% (n=12/13) of the patients had single stricture and only 1 had multiple stricture on presentation. Similarly, in the French study (9) two-third of the patients had single stricture while the remaining 1/3rd had multiple levels of stenosis. In South Africa (13) Most of the patients had a single stricture 36 (92%)

In our study, the largest proportion of patients (40%) had distal third esophageal stricture. In study done in France (9) the lower third of the esophagus was the most frequently affected region in (37%), followed by the middle (34%) and the upper 3rd (29%). But different from the study done in Bahrain (11) where 74.3% had upper strictures, eight (22.9%) patients had middle strictures, and one (2.8%) had distal stricture, also different in the study done in South Africa (13) The most common stricture site was the middle third of the esophagus (51%), with 33.3% in the upper-third and 16% in the lower-third, in Turkish study (18) middle esophagus is the most affected (62%), followed by upper in 22% and lower in 16%.

In our series, (3/13) 23% of the patient came in malnutrition and dehydration and they needed to have feeding gastrostomy and nutritional rehabilitation before any kind of procedure can be done. In study done at France (9), 1/3rd needed gastrostomy prior to the procedure, in India (14) 5.4% needed feeding jejunostomy. In a series done in China (17) 38% (5/13) patients received jejunostomy because of nutritional problems.

For all the patient for who we collected the record for has had undergone 30 dilation procedure done for 13 of the patients. Esophageal dilation with mercury weighted Malony bougie dilator was done. No patient underwent pneumatic balloon or guide wire directed dilation. Bougie dilation was done from once to 9x per patient the median being 2 times and the mean is 2.4 times. Most of our patient, 46% (6/13), underwent dilation twice while 38% (5/13) underwent esophageal dilation once

. In Bahrain study (11) , it was reported that the median number of dilatations per patient was 3 , with a range of 1 to 8 dilatations per patient. In the study done at 3 different hospital at UK and HK, The mean number of Endoscopic Balloon Dilation(EBD) per patient was 3.4 (range, 1 to 19) In Bahrain, (11) It was reported that the median number of dilatations per patient was 3, with a range of 1 to 8 dilatations per patient. In Iran(15) The frequency of balloon dilatation was as follows for each patient: 1, 2-, 3-, 4-, and 5-times dilatation were performed in 15 (48.4%), 8 (25.8%), one (3.2%), 5 (16.1%) and 2 (6.5%) patients, respectively. According to this data, only one session was effective in 48.4% of children. Overall, in 23 (74.2%) patients, clinical problems were resolved with 1 - 2 times dilatation.

Interval between dilation sessions for each case was more than 2 weeks in 4/13 of the cases only for different reasons. Otherwise most of the cases were dilated within 2 weeks interval. 69 % (9/13) of the children in our series had follow up for only less than 6 month after dilation for esophageal stricture, which is shorter than the study seen at different studies in France(9) : 40 months mean follow-up (range of 20-109 months) after balloon dilation for esophageal stricture in 49 young patients while in the study at UK and Hong Kong : 6.6 years median follow-up after flexible upper gastrointestinal endoscopy and balloon dilation for esophageal stricture in 77 children(10). The series in Bahrain(11) 6 years median follow-up after esophageal dilation, primarily using a dilator, for esophageal stricture in 46 children. in Turkey (12) 44 months mean follow-up (median of 41 months, range of 1-138 months) after fluoroscopy-guided esophageal balloon dilation in 116 children while in South Africa(13) 3 years of follow-up after esophageal dilation for esophageal stricture in 39 patients India .(14) : 16 months mean follow-up (range of 1-99 months) after bougie dilation for benign esophageal strictures in 107 children while in China(17) 39 months mean follow up (range of 29–70 months) after endoscopic therapy (dilation or dilation and stent implantation) for caustic esophageal stricture in 13 patients. In another study in Turkey (18) 35 months median follow-up (range of 4–96 months) after fluoroscopically guided endoscopic bougie dilation to treat 38 children with caustic esophageal stricture.

The response after dilation was (6/13) 46 % had complete response after single dilation session. 9/13 patients were discharged improved with success rate of 69%. In the France study (9) The success rate of the treatment was 86%, with 12% of the patients requiring additional surgery to address residual stenosis. In UK and HK study (10), multicenter study, a study conducted over 17 years, examining endoscopic balloon dilation (EBD) in children, reported a 97% success rate. The study considered an outcome successful if symptoms were relieved after a maximum of 28 months In Bahrain (11): This study from Bahrain evaluated the efficacy and safety of endoscopic esophageal dilation in children, reporting a primary efficacy of 98.8%. This high rate refers to the success of individual dilation sessions, with complete resolution achieved in 69.2% of the patients. In a Turkish (12) study examining fluoroscopy-guided balloon dilation for benign esophageal strictures in children, the clinical success rate was 34% per procedure and 85% per patient. In an Indian study (14), bougie dilation for benign esophageal strictures in children proved successful in 93.7% of the case. This Iranian study(15) investigated endoscopic balloon dilation in children with benign esophageal strictures, finding that 74.2% of patients experienced clinical problem resolution after 1-2 dilations. The study also highlights that a single dilation session was effective in 48.4% of children. The Indian newer study(16) compared bougie versus balloon dilation for benign esophageal strictures. The overall efficacy of dilation was 90.32% across 186 analyzed cases The Chinese [17] case series study focused on endoscopic therapy (including dilation and stent implantation) for caustic esophageal strictures, reporting a success rate of 92%. Success was defined as the ability to swallow solid or semi-solid food without dysphagia for at least 24 months This Pakistani study (19) highlights that 70% of patients who underwent dilation only showed an improved outcome

In our current series, 30% (4/13) perforation rate was observed . Among the 4 cases which perforated 3 of them were managed with feeding gastrostomy and chest tube. 2 of them improved and discharged and 2 of them died with mortality rate of the procedure of 6.6 % . Half of the perforated cases had corrosive ingestion as a cause of esophageal stricture, 1 had congenital stricture the other one had post foreign body swallow esophageal stricture. Similarly , In the study conducted in France(9), 3 cases of esophageal perforation were observed, accounting for 6% of the patients or 2% of the procedures. However, all perforations healed without further intervention in Uk and HK(10), across three centers and a total of 77 patients with esophageal strictures, found that over the course of 260 dilations, there were 4 perforation complications (1.5%) attributed to overenthusiastic dilata-

tion. A retrospective study from Turkey.(12), reviewing medical records of children who underwent fluoroscopy-guided esophageal balloon dilation for benign esophageal structure from February 2008 to July 2019, found a total complication rate of 0.5% per procedure (375 balloon dilations in 116 patients) and a perforation rate of 0.25% per session. A retrospective chart review in South Africa(13), from 2017 and covering 39 patients with esophageal stricture ages ranging from one month to 13 years old, reported that perforation occurred in eight cases (3.1%) out of 287 attempted dilations. A report covering 8.5 years of experience with bougie dilation on 111 Indian children, conducted in 2001(14), noted that six perforations occurred during 648 dilation sessions (0.9%). A retrospective observational study from India(16), managing 259 children with esophageal strictures between June 1994 and March 2020, found that the perforation rate in the overall cohort for balloon dilation was 0.51% (5/970) and that for bougie dilation was 0.37% (6/1610). A retrospective review of 369 EBD sessions using fluoroscopically guided EBD to treat 38 children with caustic ES between November 2004 and November 2012 at Turkey(18) reported six (1.6%) esophageal perforations in five patients (13.2%). A single-center prospective study conducted in Multan, Pakistan(19) found that pneumothorax occurred in one patient as a complication during the process of dilatation.

From the followed patient only (2/13) had recurrence within 3 months of the last procedure with a rate of 15%. A South African chart review (13) in 2017, with a 3-year follow-up period, found that recurrence of esophageal stricture was observed in 12/39 (32.4%) patients. The study done in France(9) between April 2002 and August 2009, with an average follow-up of 40 months, reported that 12% of patients required additional surgery to address residual stenosis otherwise no report on recurrence. In the UK and HK review (10), A review of 77 patients treated between July 1984 and December 2002, with a median follow-up of 6.6 years, found that all patients who initially had successful outcomes continued to be symptom-free

Conclusion

The study examined the management and outcomes of esophageal strictures. The age range was from 1.5 to 12 years, the majority being younger than 3 years presented with dysphagia. Etiologies of the strictures were diverse, including congenital, post-esophageal foreign body removal and post-surgical. Barium swallow was the primary diagnostic modality. The majority had a single stricture, with the distal third of the esophagus being the most common location. Bougie dilation was the primary treatment approach, with an average of 2.3 dilation sessions. About half of them exhibited complete response to dilation with single session and an overall response rate of 69%. The perforation rate was relatively higher but the recurrence was lower than similar studies. This indicates that the bougie dilation is viable alternative in the management of esophageal strictures in children in resource limited setups.

Patient Data

Age	Sex	presenting symptom	Duration	etiology	dx	number of stricture	site of stricture	FG	length of stricture	number of dilation	interval between each dilation	duration of follow up	recurrence	interval to recurrence	response after each dilation	Managed if failed /complicated	Definitive management	Out come
4 yr	M	D+V	3 yrs	CES	BS	1	middle	yes	short	once	< 2 wks	1 yr-2 yrs	no		failure	FG only,	REEA	DC
7yrs	M	D+V	7 yrs	CES	CT	1	distal	no	short	2x	> 2 wks	< 6 mnth	no		IR			DC
1 yr & 8 mths	M	D	6 mths	PS	UGE	1	proximal	no	short	2x	> 2 wks	< 6 mnth	no		CR			DC
12 yrs	F	D+V	3 mths	other	BS	1	distal	no	short	2x	< 2 wks	< 6 mnth	no		CR			DC
2yrs & 10months	D	D	1 mth	corrossive	BS	1	proximal	no	long	> 5x	> 2 wks	6 month - 1 year	yes	3 mths	IR+ perforation	TT & FG		DC
2Yr	M	D	5 mth	PFBS	UGE	1	middle	no	short	2x	< 2 wks	< 6 mnth	no		CR			DC
3Yr	F	D	2 mth	PS	BS	1	middle	no	short	2x	< 2 wks	< 6 mnth	no		CR			DC
2yrs & 7 mth	M	D	9 mnth	corrossive	BS	>2	proximal	yes	short	once	< 2 wks	6 month - 1 year	no		perforation	TT & FG	REEA	Death
2 yrs	M	D+V	1 yr	CES	BS	1	distal	no	short	once	< 2 wks	< 6 mnth	no		perforation	TT & FG		DC
7	M	D	1 mth	peptic stricture	CT	1	distal	no	short	2x	> 2 wks	< 6 mnth	no		CR			DC
3yrs	F	D	1 yr	PFBS	UGE	1	distal	Yes	short	once		6 month - 1 year	no		CR			DC
1yr & 6 mths	F	D+V	1 mth	PFBS	BS	1	middle	no	short	once		< 6 mnth	no		perforation	TT & FG		Death
1 yr & 7 mths	M	D	6 mth	PS	BS	1	proximal	no	short	4x	> 2 wks	< 6 mnth	yes	1-3 months	IR			DC

dc- discharged improved, dysphagia- D, v- vomiting, BS-bareum swallow, CES-congenital esophageal stricture . PFBS- post foreign bodyswallow. PS- post surgical ,IR-inadequate response ,CR-complete response ,TT- thoracostomy, FG-Feeding gastrostomy

Limitation of Study

The limited number of the case because missing records, short duration of follow up, retrospective nature the study limited our study and it prohibited us to infer recommendation.

Conflict of Interest

There are no financial and personal relationships with other people or organizations that could inappropriately influence (bias) the work.

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