DILATION OF ESOPHAGEAL STRICTURES IN INFANTS AND CHILDREN: SINGLE INSTITUTION EXPERIENCE

Research manuscript

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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 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 are equally caused by congenital, post-esophageal foreign body removal, and post-surgery . Sixty one percent (8/13) had a barium swallow at 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%) uneeded a gastrostomy before dilation.. Bougi 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 dilatation 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 site of stricture. Bougie dilation was the only treatment modality, with an overall response rate of 69%. The study suggests bougie dilation as a viable alternative for resource-limited settings.

Introduction

Esophageal strictures in pediatric patients are typically benign and stem from various insults to the esophagus. The most prevalent causes of esophageal strictures include GERD, caustic ingestion, and scar tissue from surgical anastomosis. These causes can overlap, as recurrent chemical damage to the esophageal lining from Gastro-Esophageal Reflux (GERD) may worsen other stricture causes. Barium esophagography is commonly used to diagnose strictures. Strictures that measure more than 2–3 cm in length are classified as long strictures. Anastomotic strictures are generally single and short, while corrosive strictures tend to be irregular and longer. Peptic esophageal strictures are often short and found in the lower third of the esophagus.

The primary approach to treating an esophageal stricture initially involves dilation, which can be performed using either a balloon dilator or bougies. Dilation is typically carried out over a guide wire, either under fluoroscopic guidance or with direct endoscopic visualization. Initially, balloon catheter dilation is performed along with intensive medical management of GER. The advantage of balloon dilation over bougienage lies in its ability to apply a uniform radial force that gradually expands the stricture, whereas bougienage creates an abrupt shearing force that may harm the mucosa and lead to further scarring and stricture.

The balloon is incrementally inflated with contrast media, providing a fluoroscopic view of the “hourglass” shape. Success is indicated when the 'hourglass' shape is no longer visible, and multiple dilation sessions may be necessary over several months for radiographic improvement. The timing between dilation sessions is tailored to each patient but generally averages between 2 to 4 weeks. The number of dilation sessions needed varies significantly.

Additional treatment options that may enhance the effectiveness of dilation include injecting steroids or mitomycin C into the stricture. Although evidence is sparse, the use of covered stents to help maintain esophageal patency after dilation has been reported in children. The rate of perforation during balloon dilation ranges from less than 2% to 10%, with most perforations being managed successfully without surgery. Preventative strategies to minimize the risk of perforation include accurately assessing the stricture's morphology before surgery, using general anesthesia, employing fluoroscopic guidance, ensuring the guide wire remains properly positioned, selecting a balloon or bouginage size that does not

exceed the patient's esophagus size, avoiding excessive balloon inflation, and gradually increasing the size of the balloon or bouginage in subsequent sessions.

Significance of the study

Esophageal stricture has historically been treated by esophageal dilation involving bougie and balloon 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 made to the service.

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 techniques, 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 term

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 April1 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.

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 was done in France focusing on a group of 49 patients who underwent dilation for esophageal stricture from 2002 to 2009. The follow-up period after the treatment was on average of 40 months. A maximum of three dilations per procedure was done for each patient. A minimum interval of 3 weeks was maintained between two consecutive session. The success was rated by disappearance of dysphagia and weight gain 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 1 year and 8 month. The majority were male(55%).The most common causes of esophageal stricture were esophageal atresia (49%), corrosive injury (25%), and epidermolysis bullosa (14%). The rest of the cause was less common and added up to be 12 % . The most common symptoms were dysphagia (100%), vomiting (45%), and excessive salivation (37%).Two-third of the patients had a single stricture. The distal third of the esophagus was the most frequently affected region (37%), followed by the middle (34%) and the proximal 3rd (29%).Prior to the procedure, one 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. balloon sizes 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)

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) in between July 1984 and December 2002, All children presented with excessive drooling, regurgitation, progressive dysphagia. All were assessed with a contrast study to confirm the location and diameter of the stricture. Flexible upper GI endoscopy and balloon dilation was performed under GA. Their age range was 2 months to 20 years. the most common cause of stricture was post repair of esophageal atresia in 81% , reflux esophagitis 9%, tight fundoplication 2.5%, caustic injury 3.8%, and achalasia 2.5%. The 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. Fifteen percent of them needed only one procedure for effective relief of symptoms. Over the years only four perforation (1.5%) were observed owing to overenthusiastic dilatation. Among the perforated cases the common cause of the stricture was caustic stricture (75%) and esophageal atresia with primary repair (25%). Overall, there was 97% success rate (10).

46 children with esophageal strictures were studied in Bahrain in 2021. Twenty five of them were males. Eighty six percent of them presented during infancy (86.5%). All patients were having symptoms 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. Post EA/TEF repair anastomotic stricture was the major cause of esophageal strictures 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 contrary, other causes such as GERD, post-corrosive ingestion, and Epidermolysis Bullosa were found only in patients who required dilatations. Twenty six (74%) patients had proximal

strictures, eight (22.9%) patients had middle strictures, and one (2.8%) had distal stricture. The reported median number of dilatations per patient was 3, with a range of 1 to 8 dilatations per patient. Patients with non anastomotic strictures had more frequent dilatations (10 patients required 39 dilatations, mean ± SD = 4 ± 3) compared to patients with anastomotic strictures (16 patients required 49 dilatations, mean ± SD = 1 ± 2) (P = 0:007). The procedure was 98.8% (87 /88) effective. 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 developed stricture and dilatations achieved complete response the median follow-up period was six years. complications is not reprted(11)

A retrospective study was conducted in Turkey in 2022, reviewing the medical records of children who received fluoroscopy-guided esophageal balloon dilatation for the management of benign esophageal stricture between February 2008 and July 2019. There were 375 balloon dilatations performed on 116 patients (67 boys) with an age range from 1 month to 18 years and a mean age of 4.3 ± 4.8 years at the time of the first dilatation. The follow-up duration spanned from 1 to 138 months, with a median of 41 months and a mean of 44 months. The clinical success rate was observed to be 34% per procedure (120 out of 353 procedures) and 85% per patient (91 out of 107 patients). The overall complication rate for each procedure was 0.5%, while the rate of perforation was 0.25% per session.(12)

A retrospective chart review was performed in South Africa in 2017, identifying 39 patients with esophageal strictures, whose ages ranged from one month to 13 years, including 18 males (46%) and 21 females (54%). The majority of the participants were black South Africans, totaling 36 (92%). The most prevalent cause of strictures was surgical correction of esophageal atresia, accounting for 14 out of 39 cases (35.9%), followed by corrosive injury at 12 out of 39 (30.8%). HIV-related strictures were observed in 8 out of 39 children (21%), while gastro-esophageal reflux and foreign body (FB) ingestion were less common, with rates of 2 (5%) and 3 (7.6%), respectively. The most frequently affected site for strictures was the middle third of the esophagus (51%), followed by the upper third (33.3%) and lower third (16%). The majority of patients had a single stricture, with 36 (92%) presenting this way. Strictures resulting from acid ingestion were commonly found in the upper and middle thirds, whereas those resulting from

alkali ingestion were located in the lower third. Dysphagia was reported by 32 patients (82%) at the time of presentation. Seven patients (18%) did not report dysphagia, and five of these were being treated for esophageal atresia and were still breastfeeding. Contrast esophagography was utilized for diagnosis and monitoring in most patients, specifically 32 out of 46 (82%). The average duration of treatment per patient lasted 29.5 months. In total, 287 dilatations were conducted across the 39 patients; the median number of dilatations was highest among those with acid- and alkali-related injuries (10 (5-14) and 6.5 (5-10), respectively), and was lowest for those due to FB ingestion (2.5 (2-3)). Perforation occurred in only 8 cases (3.1%). During a 3-year follow-up period, recurrence of the esophageal stricture was noted in 12 patients (32.4%), most commonly after alkali ingestion (50%). Mitomycin C was administered locally in 4 patients (10.3%), with a mean of 8.7 (SD = 2.8) applications per patient. The application of Mitomycin C was linked to stricture resolution in all patients. Stenting was performed on 2 patients (5.1%), and esophageal replacement surgery was carried out for 3 patients (7.6%) following caustic injury. There were five patient deaths (13%): two due to perforations, one as a result of surgical replacement of the esophagus, and two from unrelated sepsis. Seven patients (18%) were lost to follow-up, and three (8%) were referred elsewhere..(13)

A report detailing 8.5 years of experience with bougie dilation in 111 children from India was published. Dilation was effective in 104 patients (93.7%); 3 patients underwent surgeries (2 as primary treatments and 1 after a perforation). The average age of the 107 children was 4.8 ± 3.4 years (ranging from 1 month to 14 years), with a male-to-female ratio of 3:1. The mean follow-up period was 16 months, with a range from 1 to 99 months. The most common cause was corrosive ingestion, accounting for 49%, followed by sclerotherapy-related issues at 21%, surgical complications at 13%, congenital conditions at 9%, and peptic causes at 3.5%. All children exhibited symptoms of dysphagia and vomiting, with an average symptom duration of 10.4 months (ranging from 1 month to 8 years). A feeding jejunostomy was performed on 6 children prior to dilation procedures. Nearly half of the children presented with strictures due to corrosive substances. The corrosives consumed included 34 instances of acid and 20 of alkali. Among the children with corrosive strictures, dilation was successful in 52 cases (96%). Of those with short strictures, 3 did not need any additional “as needed” dilations after the initial success, whereas all children with long and/or multiple strictures required ongoing “as needed” dilations. Dilation was successfully achieved in nearly all children with noncorrosive strictures (98%).

Dilation was deemed sufficient when the esophageal lumen expanded to 15 mm in width. Six perforations occurred during 648 dilation procedures, resulting in a rate of 0.9%. Among these cases, five involved corrosive strictures and one was due to a congenital stricture. One child necessitated surgery, while the others experienced contained perforations managed conservatively, allowing for continued scheduled dilations. (14)

In a prospective cross-sectional study conducted in 2017 at the Children's Medical Center Hospital in Tehran, 31 children with esophageal stricture (ES) were referred for endoscopy between May 2016 and June 2017. Among them, 61% (n = 19) were male. The average age was 5.1 ± 3.9 years, with a range from 1 to 15 years. The leading causes of esophageal stricture identified were achalasia (45%), esophageal atresia (19%), caustic ingestion (19%), and congenital stenosis (16%). Congenital stenosis, esophageal atresia, and achalasia were found to be more prevalent in boys, while the occurrence of stenosis due to caustic ingestion showed no gender bias. There were no complications observed following the dilation procedures. A total of 64 dilation procedures were executed, with some patients requiring more than one. The distribution of balloon dilation among patients was as follows: 1, 2, 3, 4, and 5 dilations were performed in 15 (48.4%), 8 (25.8%), 1 (3.2%), 5 (16.1%), and 2 (6.5%) patients, respectively. It was noted that only one session proved effective for 48.4% of the children. In total, clinical issues were resolved in 23 (74.2%) patients with 1 to 2 dilations. A significant 87.1% of the children (n = 27) responded positively to treatment. Resistance to therapy or recurrence of the stricture occurred more frequently in patients with stenosis resulting from caustic ingestion. Ultimately, 4 patients (12.9%) experienced treatment failure and were subsequently referred for surgical intervention.(15)

A more recent retrospective observational study involving 259 children with esophageal strictures in India was carried out from June 1994 to March 2020. The study included all children under the age of 18 diagnosed with esophageal strictures. The median age of the participants was 2.5 years, with a male-to-female ratio of 2.2:1. Out of the total, 188 children were found to have a single, short esophageal stricture. All of the children exhibited symptoms of dysphagia. Vomiting was present in 78.7% (163 out of 207), respiratory complications were noted in 24.1% (48 out of 199), and failure to thrive was observed in 57.4% (109 out of 196). The most frequent cause of strictures was identified as anastomotic, accounting for 38.2%, closely followed by

corrosive causes at 37.1%, peptic causes at 10%, congenital causes at 7.3%, post-endoscopic sclerotherapy at 5%, and other causes at 2.3%. Among the anastomotic strictures, 96 cases were associated with surgery for esophageal atresia, while 3 were related to surgery for esophageal perforation. In the corrosive category, 49 strictures were attributed to acid ingestion, 34 to alkali, and 13 were of unknown origin. The outcomes were evaluated for 186 cases; dilatation proved successful in 168 instances, resulting in an efficacy rate of 90.32%. Of the 18 cases where dilatation was unsuccessful, 14 children experienced perforations, 2 continued dilatation for unresolved strictures at the time of the last follow-up, one child underwent a two-staged colonic interposition, and another was slated for esophageal replacement surgery due to a challenging stricture with failed dilatation. The perforation rate for balloon dilatation across the entire cohort was .51% (5 out of 970), while for bougie dilatation it was .37% (6 out of 1610), and this difference was not statistically significant (P = .595). (16)

In 2013, a case series from China documented 13 patients suffering from caustic esophageal strictures who received endoscopic treatment. The average follow-up period from the last endoscopic procedure was 39 months, with a range of 29 to 70 months. The cohort included seven males and six females, with an average age of 30.69 years, spanning from 7 to 54 years old. While the report included all ages, it provided valuable information. Among the patients, three had ingested acid, six had ingested alkaline substances, and the agent was unknown for four of them. All cases involved accidental ingestion, except for one patient who consumed 200 mL of methyl ethyl ketone. The patients exhibited various clinical symptoms including heartburn, chest pain, difficulty swallowing, coughing, abdominal pain, vomiting, and hematemesis. Jejunostomy was performed on five patients prior to dilation due to nutritional issues. After the commencement of endoscopic therapy, patients frequently returned to the hospital every few weeks owing to recurring dysphagia. The average recurrence interval was 37 days. Stricture resolution was characterized by the ability to ingest semi-solid or solid foods and the absence of dysphagia for a minimum of two years. Endoscopic therapy achieved success in 92% of patients (12 out of 13), with one patient not responding to treatment. Among those who were successful, seven required only dilations, while the other five underwent both dilations and stent placements. The average duration of stricture resolution was 15 months, ranging from 4 to 48 months. No complications were reported. (17)

A retrospective analysis was conducted on 369 sessions of fluoroscopically guided endoscopic balloon dilatation (EBD) to manage caustic esophageal strictures (ES) in 38 children from Turkey between the years 2004 and 2012. The majority of cases resulted from the ingestion of strong alkali substances, with 31 (81%) cases attributed to alkali, six (16%) to acid, and one (3%) to an unknown caustic agent. The follow-up period varied from 4 to 96 months, with a median duration of 35 months. Of the patients, 61% were male, and the median age was 3.5 years, ranging from 14 months to 14 years. In 32% of the patients, there were two strictures present, with the middle esophagus being the most commonly affected area (62%), followed by the upper esophagus in 22% and the lower esophagus in 16%. Long strictures, defined as those wider than one vertebral body, were found in 61% of cases. The duration of EBD treatment was significantly shorter for the early dilatation group (n = 16) compared to the late dilatation group (n = 11). Additionally, the treatment duration for short strictures (n = 12) was also significantly shorter than for long strictures (n = 15). All EBD sessions were successfully completed in every patient. The mean duration of the procedure from entry to exit in the operating room was 34.2 minutes (± standard deviation, 9.8; with a range of 9 to 75 minutes). Seven post-operative complications were noted, which included six cases (1.6%) of esophageal perforation occurring in five patients (13.2%) and one case (0.2%) of atelectasis in one patient (2.6%). All cases of perforation were managed conservatively, involving immediate nasojejunal feeding, antibiotics, and tube thoracostomy when necessary. Eight patients were diagnosed with gastroesophageal reflux disease (GERD) through a barium swallow study, and these individuals were treated with anti-reflux medications (ranitidine or lansoprazole) until their esophageal strictures were resolved. One patient suffering from an intractable ES and severe GERD underwent Nissen fundoplication. No fatalities were reported during the course of the study. (18)

A prospective study was conducted at a single center in Multan, Pakistan. The diagnosis of esophageal stricture (ES) was established through patient history, endoscopic examination, and results from contrast-enhanced imaging. Among the 32 patients included, 19 (59.4%) were male and 13 (40.6%) were female. The ages of the patients varied from 1 to 15 years. Thirteen (40.62%) patients were between the ages of 1 and 3 years, 11 (34.38%) were from 4 to 7 years, 6 (18.75%) were from 8 to 11 years, and 2 (6.25%) were from 12 to 15 years. The average age of the patients was 36.58±19.6 months. The most common causes of ES were chemical burns (n=23; 71.9%), esophageal atresia (n=4; 12.5%), and gastroesophageal reflux disease (GERD)

(n=2; 6.3%). There were congenital causes, achalasia, and foreign body ingestion noted in 1 (3.1%) case each. Among the 32 ES cases, 24 (75%) had proximal strictures and 8 (25%) had distal strictures. In the group with chemical burns, 18 (78.3%) had proximal involvement while 5 (21.7%) had distal esophageal involvement. All four patients with esophageal atresia exhibited proximal esophageal involvement. Out of the 32 patients with ES, 10 (31.3%) underwent dilation, 1 (3.1%) had surgery, and 21 (65.6%) needed both dilation and surgery. In the chemical burn patient group, the majority (n=16/23; 69.6%) required both dilation and surgery, and 7 (30.4%) underwent dilation only. The overall treatment response was favorable in 62.5% (n=20/32) of the patients, while 37.5% showed no significant improvement through any treatment option. Among the 21 patients who required both dilation and surgery, the outcome was positive in 61.9% (n=13/21), while 70% (n=7/10) of those receiving only dilation had improved outcomes (p=0.385). Thoracotomy and esophagoplasty were performed in one patient because end-to-end anastomosis could not be achieved due to an excessively short healthy esophagus. End-to-end anastomosis was successfully carried out in 15 patients, all of whom were cured post-surgery. Pneumothorax developed in one patient, treated with chest tube insertion and oxygen therapy, resulting in improvement. Among the chemical burn patients, the treatment outcome was positive in 69.6% (n=16/23) of the cases. Mortality was observed in 3.1% (n=1/32) of the 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 being 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 .

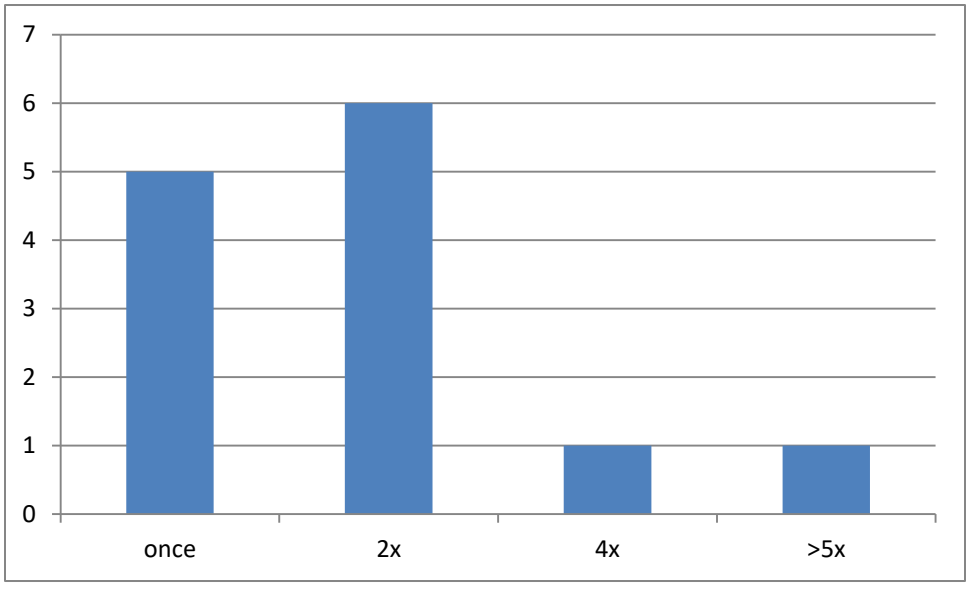

Fig .1 The frequency of esophageal dilation which was done for children who presented to Tikur

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

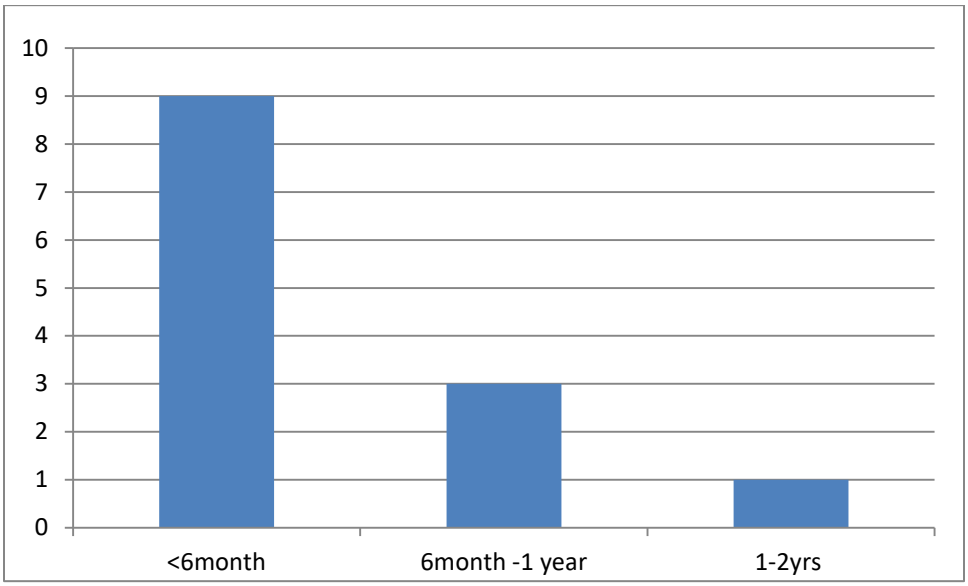

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Fig .2. The duration of follow up for children who presented to Tikur Anbessa Specialized Hospital with diagnosis of Esophageal stricture April1 , 2014 to March 31, 2024

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%.

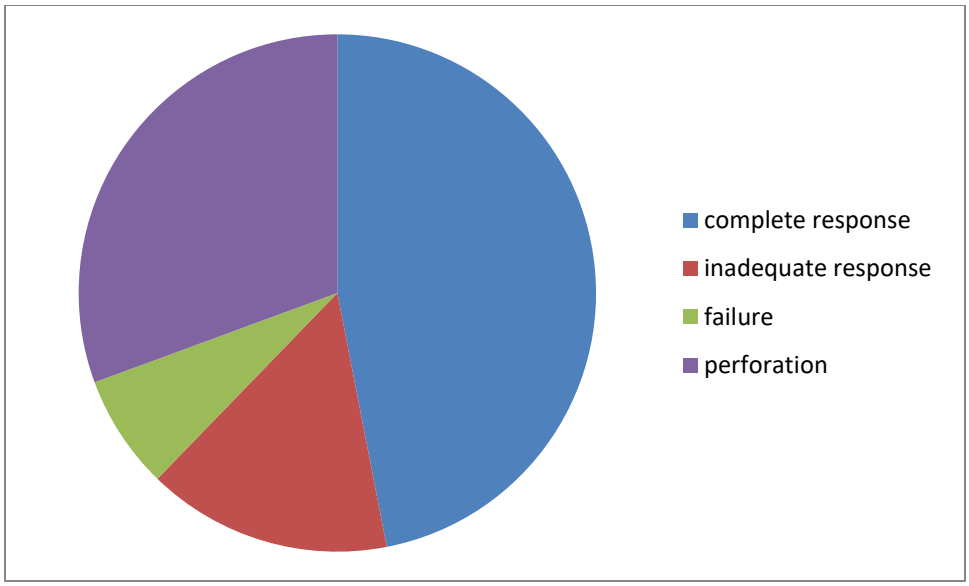

Fig. 3. The response after esophageal dilation for children who presented to Tikur Anbessa Specialized Hospital with diagnosis of Esophageal stricture from April1 ,2014 to March 31, 2024

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 month. The mean duration of illness is 1 year and 2 month. Most of the patients 53% (7/13) came at and before 6 month 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 hospital 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%), where as 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 patient, 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 jejenostomy. 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 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 French 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 dilatation. 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. Etiologies of the strictures were diverse, including congenital, post-esophageal foreign body removal and post-surgical. Barium swallow was used as a primary diagnostic modality. The majority had a single stricture, with the distal third of the esophagus being the most common site of stricture. Bougie dilation was the only treatment approach, with an average of 2.3 dilation sessions per patient to achieve response. 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 bugie dilation is viable alternative in the management of esophageal strictures in children in resource limited setups.

Limitation of study

The number of the cases as well duration of follow up was very limited 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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Annex: Patient data

Age	Sex	presenting symptom	Duration	etiology	dx	number of sticture	site of stricture	FG	length of stricture	number of dilation	between each	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 mnths	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