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Endoscopic management of benign esophageal strictures at a tertiary center in sub-Saharan Africa: a retrospective cohort study from Ethiopia

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Abstract

Introduction Benign esophageal stricture (BES) is a chronic complication of variable etiology, which is primarily managed by endoscopic interventions. Despite significant advances that have been made in therapeutic management across the world, literature on the demographic characteristics and clinical features of endoscopic management and its outcome of benign esophageal strictures is limited in the sub-Saharan Africa region. The study aimed to assess the clinical profile and endoscopic management outcomes of BES at a tertiary center in Ethiopia.

Methods A retrospective cohort study was conducted at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. Medical records from 2018 to 2022, supplemented by structured patient interviews, were reviewed for all adult patients with endoscopy-confirmed benign esophageal strictures (BES). Technical success (surgical avoidance) and short-term complete clinical response were co-primary outcomes assessed over a 3-month follow-up period. Comparative analyses between caustic and non-caustic strictures and their clinical outcomes following endoscopic therapy were performed using chi-square and Fisher's exact tests, with a p-value of <0.05 considered statistically significant.

Results Fifty-seven patients with benign esophageal strictures were included (caustic, $n=18$; non-caustic, $n=39$). Caustic injury was the most common etiology (31.6%), followed by peptic (19.3%) and postoperative strictures (17.5%); approximately one-third of patients met criteria for refractory strictures. Patients with caustic strictures were significantly younger and more likely to have proximal (38.9% vs. 15.4%), complex (66.7% vs. 12.8%), and multifocal strictures (61.1% vs. 2.6%) ($p<0.001$). A total of 333 endoscopic dilation sessions were performed with a median of 5 per patient (IQR = 2–10). The overall technical success (without subsequent surgical intervention) was achieved at 78.9% of cases. Among the 45 patients successfully managed exclusively with endoscopic dilation, complete clinical response at three months was achieved in 62.2% (28/45) without significant difference between caustic and non-caustic groups ($p=0.738$). Adjuvant intralesional steroid injection significantly improve a short term clinical outcomes (50% Vs 17.6%, $X^2=4.71$, $p=0.03$). Perforation occurred in 3.5%, resulting in one procedure-related death.

Conclusion Endoscopic dilation is an effective treatment for benign esophageal strictures, achieved technical success in approximately four-fifths of patients. Among patients successfully managed without surgery, nearly two-thirds achieved complete clinical response within three months. A short-term clinical response has no significant

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difference between caustic and non-caustic cases. The use of adjuvant intralesional steroid injections significantly enhances clinical response. The escalation of endoscopic services in resource-limited settings could further optimize outcomes in the sub-Saharan Africa region while minimizing procedure-related complications.

Keywords Benign esophageal strictures · Endoscopic dilation · Dysphagia

Introduction

Benign esophageal stricture is caused by the production of fibrous tissue and deposition of collagen stimulated by deep esophageal ulceration or chronic inflammation [1].

There is an overall low disease prevalence for the condition and a frequency rate of 1.1 per 10,000-person-years, which likewise increments with age [2]. Peptic injury accounts for 70–80% of BES cases in Western series, though its incidence has declined in parallel with widespread proton pump inhibitor use [3].

Accidental caustic ingestion and esophageal injuries remain significant medical conditions worldwide [4]. 80% of patients experiencing caustic ingestion are children and 20% were adults, however, strictures associated with gastric reflux, iatrogenic and drug-induced esophagitis are more common in adults [5].

Patients with benign esophageal stricture often present with progressive dysphagia, food impaction, odynophagia, chest pain, and weight loss as a result of progressive stricture, roughly 45% of cases detected at endoscopy, patients presenting with such clinical symptoms have an underlying stricture [5, 6].

Untreated BES (Benign esophageal stricture) patients may progressively develop serious complications like aspiration, severe chest pain, malnutrition, fistula formation, and perforation from long-standing inflammation [6, 7].

Endoscopic dilation has been the mainstay of esophageal stricture treatment for generations by interfering with the remodeling of the prior to cicatricial maturation. Currently, three types of esophageal dilators are in practice: Endoscopic Balloon Dilators (EBDs), wire-guided Salvary Gilliard bougienages (SGB), and weighted Maloney dilators. EBD is increasingly being recognized as the treatment of choice in these cases [8–10].

In addition to endoscopic dilation, supplementary approaches are employed depending on clinical context, including intralesional steroid injection, oral steroid gel, topical mitomycin C, incisional therapy, and stent placement, which are recommended for the management of recurrent strictures [11, 12].

Achieving sufficient food intake and prevention of stricture recurrence is the target of esophageal dilation in patients with esophageal stricture, The success of Endoscopic dilation can be evaluated either directly through endoscopy (appearance of mucosal tearing at the stricture area) or indirectly through the fluoroscopic study (disappearance of the stricture's waist), but the clinical resolution of dysphagia is considered the most relevant [13, 14].

Upon reviewing the literature, Successful treatment of BES by dilation and other adjuvant medication varies from center to center and mainly depends on resources, experience, and etiology of the stricture [8, 13, 15–18].

So far only three studies are available in our continent regarding BES; A Study from South Africa was done in a pediatric age group with caustic injury and showed association with HIV as a comorbidity [17] and a study in particular focus of isolated corrosive esophageal strictures in pediatric patients with exclusion of other etiologies [18], and another study from Egypt showed the effect of Mitomycin C (MMC) in reducing the number of dilation sessions and improve patients outcome [15, 16, 19]. This significant evidence gaps regarding adult mixed-etiology BES managed in resource-limited settings where fluoroscopic guidance, advanced dilator options, and surgical backup may not be uniformly available.

This study therefore aims to describe the clinical profile, endoscopic management practices, and short-term outcomes of BES in a mixed-etiology adult cohort at a tertiary center in Ethiopia, with a specific focus on comparing caustic and non-caustic strictures and evaluating the role of adjuvant intralesional steroid injection in enhancing clinical response.

Methods

Study design

A retrospective cohort study was conducted at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. Medical records of patients with benign esophageal strictures (BES) who underwent endoscopic dilation and received follow-up care between January 2018 and December 2022 were retrospectively reviewed to evaluate the etiology and clinical profile of BES, and short-term clinical outcomes of endoscopic management. Data were collected from February 15 to March 15, 2023, using a structured data collection tool. Eligible patients were identified through review of medical records, and relevant clinical, endoscopic, and treatment-related information was abstracted. In addition, patients or their caregivers were contacted by telephone to obtain complementary updated information on their most recent clinical status, persistence or recurrence of dysphagia, need for repeat endoscopic dilation, and complications following endoscopic management.

Study setting and population

Patients aged < 14, confirmed and suspected esophageal malignancy suspicious of malignancy, as indicated by a request for repeat biopsy and those with incomplete data or missing medical records were excluded. All upper gastrointestinal endoscopic procedures and esophageal dilations were performed by experienced senior gastroenterologists using standardized techniques and treatment protocol. Esophageal dilation was performed using Savary–Gilliard dilators, balloon dilators, or a combination of both modalities, according to the anatomical characteristics of the stricture, clinical indications, and the treating gastroenterologist's discretion.

Treatment protocol and procedure

Given the retrospective nature of the study, endoscopic procedures were not fully standardized but were performed according to local clinical practice and prevailing recommendations for endoscopic dilation (ED). The choice of endoscopic technique, sedation, and treatment strategy was individualized according to stricture characteristics, clinical presentation, and the treating endoscopist's assessment.

ED was the primary treatment modality and was performed using through-the-scope balloon dilators and/or wire-guided Savary–Gilliard bougie dilators. The choice of dilation method was guided by stricture morphology and technical considerations. Balloon dilation was generally used for selected simple or short strictures, whereas Savary–Gilliard bougie dilation was preferentially used for tight, fibrotic, long, or complex strictures. Combined balloon and bougie dilation was used selectively when gradual or progressive luminal expansion was required or when adequate dilation could not be achieved with a single modality [20, 21].

Dilation was performed in a stepwise manner, with the extent of luminal expansion determined by stricture characteristics, procedural resistance, and patient tolerance. Although no universally accepted endpoint for dilation therapy exists, a luminal diameter of approximately 14–15 mm was generally targeted, consistent with guideline recommendations and evidence associating achievement of this diameter with symptomatic improvement. For bougie dilation, sequential Savary–Gilliard dilators were advanced over a guidewire, generally following the traditional "rule of three," with no more than three sequential dilators passed after moderate resistance was encountered. The procedure was discontinued in the event of significant resistance, severe pain, bleeding, or suspected perforation.

Repeat dilation sessions were scheduled according to clinical response and endoscopic findings, generally at intervals of 2–4 weeks, although more frequent sessions were occasionally required for persistent or refractory strictures. For the purposes of this study, subsequent endoscopic interventions performed within 7 days were considered a single treatment cycle.

Adjunctive intralesional triamcinolone injection was selectively administered to patients with inadequate response after initial dilation or those with recurrent or refractory strictures requiring repeated dilation. Triamcinolone acetonide (40 mg/mL) was injected in 0.5-mL aliquots into four quadrants of the stricture using a 23-gauge, 4-mm needle immediately before dilation, with the needle maintained in position briefly after injection to minimize drug leakage and facilitate intralesional delivery [20].

Other interventions, including temporary esophageal stent placement, were considered on a case-by-case basis according to stricture characteristics and treatment response. Patients who failed repeated endoscopic therapy to achieve or maintain adequate luminal patency, had persistent refractory dysphagia, or developed complications requiring definitive management were referred for surgical evaluation. Clinical follow-up focused primarily on dysphagia resolution based on Mellow–Pinkas Dysphagia Score, the need for repeat intervention, and maintenance of adequate luminal patency.

Data collection

We reviewed the electronic medical records of the included patients and conducted a telephone interview with a structured questionnaire that included basic patient characteristics (age, gender, marital status, occupation, region, and comorbidities), esophageal stricture characteristics of the patients (etiology, location of stricture, mechanism of injury and number of stricture), and endoscopic management of benign esophageal strictures (type of endoscopic intervention, number of dilation sessions, use of intralesional steroid injection, need of surgery and complication related to the procedure), technical/ procedural success and short term complete clinical response were evaluated.

Statistical analysis

For the analysis, we used the Statistical Package for the Social Sciences (SPSS), version 26. Frequencies and percentages were calculated for the categorical variables. Continuous variables were presented as mean and standard deviation (SD) or median and interquartile range (IQR). Comparison between groups was performed using Pearson chi-square and Fisher's exact test for categorical variables. For continuous variables, comparisons were conducted using the Student's *t*-test or the Mann–Whitney U test, as appropriate. A p-value of <0.05 was considered statistically significant.

Operational definition [22–25]

Simple stricture

A benign esophageal stricture that is short (<2 cm), straight, concentric or symmetric, and allows passage of a standard diagnostic endoscope, with a low risk of recurrence after dilation

Complex stricture

A benign esophageal stricture that is long (≥2 cm), angulated, irregular, tortuous, or severely narrowed such that a standard diagnostic endoscope cannot be passed, and is typically associated with recurrent or refractory dysphagia requiring repeated dilations

Short-segment stricture

An esophageal stricture measuring less than 2 cm in length on endoscopy or contrast imaging

Long-segment stricture

An esophageal stricture measuring 2 cm or more in length on endoscopy or contrast imaging

Proximal esophagus stricture

The upper one-third of the esophagus, extending from the upper esophageal sphincter (UES) to approximately 25 cm from the incisors during upper gastrointestinal endoscopy

Mid-esophagus stricture

The middle one-third of the esophagus, extending from approximately 25 cm to 32 cm from the incisors during upper gastrointestinal endoscopy

Distal esophagus stricture

The lower one-third of the esophagus, extending from approximately 32 cm from the incisors to the gastroesophageal junction (GEJ), usually located at 40 cm from the incisors in adults, although slight variation may occur depending on patient height

Multiple-segment esophageal stricture

The presence of two or more distinct areas of luminal narrowing involving separate segments of the esophagus, with intervening relatively normal mucosa, identified on endoscopy

Dysphagia severity

Was assessed using the Mellow–Pinkas Dysphagia Score, a standardized five-point ordinal scale based on swallowing ability according to the patient's ability to tolerate oral intake. The score was defined as follows: Grade 0 = able to consume a normal diet without difficulty; Grade 1 = able to swallow some solid foods; Grade 2 = able to swallow semisolid foods only; Grade 3 = able to swallow liquids only; and Grade 4 = complete dysphagia, defined as inability to swallow saliva

Clinical improvement

Was assessed using the Mellow–Pinkas dysphagia score (0–4) when an improvement was defined as a decrease of at least one point from baseline

Short-term complete clinical response

Was defined as a post-treatment score of 0 or 1, indicating the ability to tolerate a normal or near-normal oral diet and resolution of symptoms with no further need for endoscopic intervention and no recurrence for at least 3-month period after last session of intervention

Technical success

Successful completion of endoscopic dilation with passage of the dilating device across the stricture, achievement of the intended luminal diameter without immediate procedure-related complications, and no requirement for subsequent surgical intervention

Satisfactory (partial) response

Was defined as improvement of symptoms with persistence of mild symptoms requiring continued surveillance but without the need for surgical intervention

No response (Inadequate)

Was defined as persistence or recurrence of symptoms despite at least five endoscopic dilation sessions

Incomplete clinical response

Was defined as the combination of partial and no response

Refractory benign esophageal stricture

Was defined as failure to achieve or maintain satisfactory luminal patency (≥14 mm) after five sequential dilation sessions performed at 1–2-week intervals, or inability to maintain the target diameter for at least 4 weeks once achieved

Result

Demographic and clinical characteristics

The study assessed 57 patients with benign esophageal strictures, categorized into caustic ($n=18$) and non-caustic ($n=39$) induced groups of benign esophageal strictures. The mean age of patients in the caustic group was significantly lower at 28.22 years (SD ± 9.65) compared to 41.23 years (SD ± 15.10) in the non-caustic group ($p<0.001$). Notably, the caustic group had a greater percentage of patients who were 30 years of age or younger (66.7%) than the non-caustic group (28.2%), indicating a significant age-related difference ($p=0.038$).

The gender distribution of the BES patients was similar between the caustic and non-caustic groups ($p=0.808$), with thirty-three (57.9%) being female and twenty-four (42%), being male. However, marital status revealed a stark contrast; only 27.8% of the caustic group was married compared to 74.4% in the non-caustic group, which was statistically significant ($p=0.004$).

Gastroesophageal reflux disease (GERD) was the most common cause of non-caustic benign esophageal stricture, accounting for 11 cases (28.2%). Postoperative strictures were the second most frequent etiology, comprising 10 cases (25.6%), These strictures occurred at esophagogastric anastomoses following reconstruction for traumatic esophageal injury ($n=3$), repair of congenital esophageal anomalies ($n=2$), and surgery for severe corrosive injury ($n=2$). In the remaining three cases, the indication for the previous surgery could not be determined from the available medical records.

Strictures of undetermined etiology were the third most common category, comprising 9 cases (23.0%) of non-caustic strictures and 15.8% of all BES cases. An extended diagnostic evaluation was undertaken in these patients to identify an underlying etiology. Chest computed tomography (CT) was performed in six patients and demonstrated esophageal wall thickening and luminal narrowing without evidence of a periesophageal or mediastinal mass. Two patients with a high clinical suspicion of esophageal tuberculosis underwent further targeted investigations. Additional targeted diagnostic work-up was also performed in one patient with suspected eosinophilic esophagitis and another with suspected malignancy, including cross-sectional imaging, three esophageal biopsy procedures, and tumor-marker assessment. Despite these investigations, no definitive underlying etiology was

established. Accordingly, after comprehensive clinical, endoscopic, radiological, and histopathological evaluation, these cases were classified as idiopathic benign esophageal strictures.

Among patients who ingested the caustic agent, an alkaline detergent and unidentified agent was accounted for 7 case (38.8%), whereas the remaining four patients (22.2%) had ingested acid substances. Most patients 15(83.3%) with corrosive benign esophageal strictures had ingested the agent with suicidal intent, but three patients ingested unintentionally, Suicide attempts were frequent in women (64.2%) while two-thirds of men (66.6%) had an unintended corrosive ingestion.

Dysphagia was the universal symptom reported by all patients with BES regardless of the cause. Other symptoms such as heartburn were more common in the caustic group (94.4%) compared to the non-caustic group (84.6%), Around 40 (70.2%) of patients had a history of using proton pump inhibitors for their symptoms and its usage rate was similar across the groups (61.1% for caustic vs. 74.4% for non-caustic) ($p=0.31$) indicates that both groups are receiving similar medical management. More than half of patients with BES had a comorbid condition, the presence of these comorbidities was significantly higher in the non-caustic group 26(45.6%) than in caustic group 5(8.7%) ($p=0.006$), and the predominantly identified comorbidities were anemia (36.8%) and hypertension (8.8%) were seen in patients with BES.

Radiological assessment was performed before endoscopic evaluation using barium swallow examination and chest computed tomography (CT) when clinically indicated to assess the location, extent, and severity of the strictures. Barium swallow examination was performed in 44 patients (77.2%). Among these, 26 patients (59%) demonstrated smooth, concentric luminal narrowing, while the remaining patients (41%) showed irregular or asymmetric narrowing. Regarding stricture number and length, most patients (66.2%) had a single stricture, whereas the remaining patients had multiple strictures. In terms of stricture length, 27.0% were classified as short-segment strictures (<2 cm), while the remaining 73.0% were long-segment strictures (≥2 cm). Proximal esophageal dilatation with delayed passage of contrast was noted in 14 patients (31.8%) with more severe luminal narrowing. Chest CT was performed in six patients with complex strictures or suspected complications and as part of the diagnostic work-up for strictures of unknown etiology.

Further characterization of stricture morphology was performed endoscopically in all study participants. Patients with caustic injuries were significantly more likely to develop complex strictures (66.7%) and multiple-segment stricture (61.1%) compared to non-caustic patients who developed complex (12.8%) and multiple-segment stricture (2.6%) ($P<0.001$). Similarly, proximal strictures were also more frequently observed in the caustic group (38.9%) than in the non-caustic group (15.4%; $p<0.001$). In contrast, distal strictures were exclusively found in non-caustic patients (59%) and not observed in the caustic group ($p<0.001$) 12 (Table 1) .

Treatment outcomes and its associated factors

Endoscopic dilation is the standard of care for esophageal stricture management and was attempted in all 57 patients. The overall technical success rate (as defined as was defined as successful completion of endoscopic dilation with passage of the dilating device across the stricture, achievement of the intended luminal diameter without immediate procedure-related complications, and no requirement for subsequent surgical intervention) was 78.9% (45/57 patients) with a relative higher success rate in non-caustic group (82.1%) than caustic group (72.2%) however, this difference was not statistically significant ($P=0.397$).

The remaining 12 patients (21.1%) required surgery because of persistent refractory benign esophageal strictures that failed to achieve or maintain adequate luminal patency despite repeated endoscopic dilation ($n=5$), inability to traverse the stricture with a guidewire or dilator ($n=4$) and procedure-related perforation ($n=3$). The proportion of patients who required surgery following endoscopic dilation was higher among those with caustic strictures than among those with non-caustic strictures (27.8% vs. 17.9%, respectively), although the difference was not statistically significant ($P=0.397$) **(**Table 2**).** Among the 45 patients who successfully underwent endoscopic dilation, short-term complete clinical response was achieved in 62.2% (28/45) during the three-month follow-up period, whereas 17 patients (37.8%) had an incomplete clinical response.

Table 1 Demographic and clinical characteristics of patients with benign esophageal strictures in relation to caustic and non-caustic cause

Demographic and Clinical Characteristics	Caustic ($n=18$)	Non-caustic ($n=39$)	Total ($N=57$)	P-value
Age (years), Mean (SD)	28.22 ± 9.65	41.23 ± 15.10		0.001*
Age Category				
≤30 years	12 (66.7%)	11 (28.2%)	23 (40.4%)	0.016*
31–45 years	3 (16.7%)	8 (20.5%)	11 (19.3%)	
>45 years	3 (16.7%)	20 (51.3%)	23 (40.4%)	
Gender				
Male	8 (44.4%)	16 (41.0%)	24 (42.1%)	0.808
Female	10 (55.6%)	23 (59.0%)	33 (57.9%)	
Marital Status				
Married	5 (27.8%)	29 (74.4%)	34 (59.6%)	0.004*
Single	11 (61.1%)	9 (23.1%)	20 (35.1%)	
Divorced	2 (11.1%)	1 (2.6%)	3 (5.3%)	
Residence				
Urban	13 (72.2%)	19 (48.7%)	32 (56.1%)	0.171
Rural	4 (22.2%)	11 (28.2%)	15 (26.3%)	
Semi-urban	1 (5.6%)	9 (23.1%)	10 (17.5%)	
Comorbidities				
Hypertension	0 (0.0%)	5 (12.8%)	5 (8.8%)	0.112
HIV	1 (5.6%)	3 (7.7%)	4 (7.0%)	0.769
Cardiac disease	0 (0.0%)	1 (2.6%)	1 (1.8%)	0.493
Anemia	4 (22.2%)	17 (43.6%)	21 (36.8%)	0.12
Medication Use				
PPI use	11 (61.1%)	29 (74.4%)	40 (70.2%)	0.31
Social History				
Alcohol use	1 (5.6%)	3 (7.7%)	4 (7.0%)	0.769
Clinical Presentation				
Dysphagia	18 (100%)	39 (100%)	57 (100%)	NA
Heartburn	17 (94.4%)	33 (84.6%)	50 (87.7%)	0.293
Odynophagia	2 (11.1%)	3 (7.7%)	5 (8.8%)	0.671
Choking	1 (5.6%)	4 (10.3%)	5 (8.8%)	0.56
Stricture Characteristics				
Morphology of Strictures				
Simple	6 (33.3%)	34 (87.2%)	40 (70.2%)	<0.001*
Complex	12 (66.7%)	5 (12.8%)	17 (29.8%)	
Location				
Proximal	7(38.9%)	6(15.4%)	13(22.8%)	<0.001*
Mid	0 (0.0%)	9(23.1%)	9(15.8%)	
Distal	0 (0.0%)	23(59%)	23(40.4%)	
Multiple segment	11 (61.1%)	1 (2.6%)	12 (21.1%)	

Data are presented as number (%), mean ± standard deviation, or. Pearson chi-square or Fisher's exact test was used for categorical variables, while Mann–Whitney U or Student's t-test was used for continuous variables. *Statistically significant at $p<0.05$, GERD: Gastroesophageal Reflux Disease, HIV: Human Immunodeficiency Virus, PPI: Proton Pump Inhibitor

Balloon dilation as only intervention constituted the most common endoscopic therapeutic modality in both caustic and non-caustic groups (38.9% vs. 35.9%, respectively), with no statistically significant intergroup difference ($p=0.828$) (Table 2).

A total of 333 ED sessions was performed in 57 patients with the median of dilation being 5 (IQR = 2–10) per patient with a range of one to twenty dilation per patient, however there was no statistically significant difference in the median number of ED sessions across caustic and non-caustic group (5.72 Vs 5.90, $p=0.894$). Similarly, Two hundred fifty-nine ED sessions was conducted in 45 patients without a significantly difference between patients who achieved complete clinical response and those with incomplete clinical response (4.79 Vs 5.70,

Table 2 Factors of Endoscopic management in patients with benign esophageal strictures in relation to caustic and non-caustic cause

Treatment Characteristic	Caustic ($n=18$)	Non-caustic ($n=39$)	Total ($N=57$)	P-value
Dilation Technique Used				
Balloon dilation	13 (72.2%)	35 (89.7%)	48 (84.2%)	0.081
Bougie dilation	7 (38.9%)	21 (53.8%)	28 (49.1%)	0.284
Combined balloon and bougie	7 (38.9%)	13 (33.3%)	20 (35.1%)	0.683
Treatment Sessions (Mean ± SD)				
ED sessions ($n=57$, 333 times)	5.72 ± 4.78	5.90 ± 4.52	5.84 ± 4.59	0.894
Balloon sessions	5.27 ± 3.88	4.88 ± 4.27	4.99 ± 4.15	0.766
Bougie sessions	2.88 ± 1.64	3.50 ± 2.12	3.32 ± 2.00	0.461
Adjuvant Therapy				
Intralesional steroid injection	6 (33.3%)	11 (28.2%)	17 (29.8%)	0.694
Steroid sessions ($n=17$)	2.67 ± 1.86	3.55 ± 4.34	3.24 ± 3.61	0.647
Stent placement	1 (5.6%)	0 (0.0%)	1 (1.8%)	0.138
Required feeding tube	6 (33.3%)	6 (15.4%)	12 (21.1%)	0.122
Treatment Modalities				
ED alone (Procedure success rate)	13 (72.2%)	32 (82.1%)	45 (78.9%)	0.397
Surgery after failed ED	5 (27.8%)	7 (17.9%)	12 (21.1%)	0.397
Clinical Response				
Complete clinical response	11 (61.1%)	22 (56.4%)	33 (57.9%)	0.738
Incomplete clinical response	7 (38.9%)	17 (43.6%)	24 (42.1%)	0.738
Complications				
Bleeding	1 (5.6%)	0 (0.0%)	1 (1.8%)	0.138
Perforation	2 (11.1%)	0 (0.0%)	2 (3.5%)	0.034*
Infection	0 (0.0%)	1 (2.6%)	1 (1.8%)	0.493
Mortality	1 (5.6%)	0 (0.0%)	1 (1.8%)	0.138

Data presented as n (%), Mean P-values calculated using Chi-square test or Fisher's exact test for categorical variables and Mann–Whitney U or Student's t-test was used for continuous variables as appropriate, *Statistically significant at $p<0.05$

$P=0.396$) (Table 3). Approximately one-third (33%) of patients with benign esophageal strictures required more than five dilation sessions and failed to maintain luminal patency, thus meeting the criteria for refractory BES.

Steroid injections were incorporated into the treatment protocol to enhance the efficacy of endoscopic dilation by reducing inflammation. Seventeen patients received intralesional steroid injections. Although the mean number of injections differed between groups (2.67 ± 1.86 in the caustic group vs. 3.55 ± 4.34 in the non-caustic group), this difference was not statistically significant ($p=0.647$) (Table 2).

However, analysis of factors associated with treatment response demonstrated that the use of steroid injections was significantly associated with a higher likelihood of complete response (50% Vs 17.6%, $X^2=4.71$, $p=0.03$) (Table 3).

Regarding complications, a total of five complications were observed. Four non-fatal complications yielded a non-fatal complication rate of 7.0%: two patients (3.5%) in the caustic etiology group developed mild to moderate perforation, one patient (1.8%) in the caustic group experienced minor bleeding, and one patient (1.8%) in the non-caustic group developed an infectious episode; all were managed successfully. Additionally, one patient (1.8%) suffered severe esophageal perforation with massive bleeding and could not be salvaged despite aggressive resuscitation, resulting in a procedure-related mortality rate of 1.8%. The overall complication rate including the fatal event was 5/57 (8.8%).

The overall surgical intervention for failed endoscopic dilation was 21%, with a relatively higher frequency (27.8%) in caustic etiology than non-caustic benign esophageal strictures (17.9%) (Table 2). Moreover, the need for surgery after unsuccessful dilation was significantly associated with a reduced probability of complete clinical recovery ($P=0.02$) (Table 3).

Table 3 Factors associated with clinical outcome of endoscopic dilation in patients with benign esophageal strictures

Factors	Partial/No Response ($n=17$)	Complete Response ($n=28$)	P-value
Patient Characteristics			
Age (years)	40.94 ± 14.27	33.84 ± 14.82	0.141
Age group[a]			
≤30 years	5 (29.2%)	16 (48.5%)	0.196
>30 years	12 (70.8%)	17 (51.5%)	
Gender[a]			
Male	8 (47.1%)	13 (46.4%)	0.967
Female	9 (52.9%)	15 (53.6%)	
Etiology[a]			
Caustic ($n=14$)	6 (35.3%)	8 (28.6%)	0.637
Non-Caustic ($n=31$)	11 (64.7%)	20 (71.4%)	
Type of Non-Caustic cause (N =31)[a b]			
GERD/Peptic	2 (18.2%)	7 (35.0%)	0.875
Post-surgery	3 (27.3%)	4 (20.0%)	
Post-radiotherapy	1 (9.1%)	1 (5.0%)	
Rings and webs	2 (18.2%)	4 (20.0%)	
Unknown	3 (27.3%)	4 (20.0%)	
Morphology of Strictures[a]			
Simple	11 (64.7%)	22 (75.0%)	0.308
Complex	6 (35.3%)	6 (25.0%)	
Category of Location of Stricture[a]			
Proximal	4 (23.5%)	5 (17.9%)	0.695
Mid	4 (23.5%)	3 (10.7%)	
Distal	5 (29.4%)	15 (53.6%)	
Multiple Segment	4 (23.5%)	5 (17.9%)	
Dilation Technique Used[a]			
Balloon dilation alone	10 (58.8%)	6 (25.0%)	0.084
Bougie dilation alone	1 (5.9%)	4 (16.7%)	
Combined balloon and bougie	6 (35.3%)	14 (58.3%)	
Steroid Use †			
Steroid injection ($n=17$)	3 (17.6%)	14 (50.0%)	0.030
Steroid injection session ($n=17$)	4.00 ± 1.00	3.07 ± 3.97	0.116
ED sessions ($n=45$: 259 times) †			
ED sessions, mean ± SD	4.79 ± 3.67	5.70 ± 3.12	0.396
Balloon sessions, mean ± SD	4.89 ± 3.65	5.07 ± 4.46	0.883
Bougie sessions, mean ± SD	3.38 ± 1.51	3.70 ± 2.26	0.577

Data are presented as number (%), mean ± standard deviation, or. [a] Pearson chi-square or Fisher's exact test was used for categorical variables where expected cell frequencies are <5, †Mann–Whitney U or Student's t-test was used for continuous variables, [b] Percentages for the type of non-caustic cause are calculated using non-caustic patients as the denominator: $n=11$ in the Partial/No Response group and $n=20$ in the Complete Response group. *Statistically significant at $p<0.05$

Discussion

In this cohort of 57 adults with benign esophageal strictures managed at a single Ethiopian referral center with an overall technical endoscopic dilation achieved in four-fifths of patients and a short-term complete symptomatic resolution achieved in nearly two-thirds of patients who underwent ED exclusively. The adjuvant intralesional steroid injection triples the odds of complete clinical response. These outcomes were achieved despite a case mix skewed toward refractory BES that evidenced by one in three patients met criteria for refractory disease. Caustic strictures were accounted in the majority of cases with complex type of stricture with young and female predominance. The study highlights an etiology based comparison of BES and the endoscopic intervention outcomes in mixed case BES in the resource constraints setting of a sub-Saharan African single tertiary center.

The demographic divergence between caustic and non-caustic strictures reproduces a pattern seen wherever caustic injury is driven by self-harm rather than accidental exposure. Caustic-stricture patients were on average 13 years younger, disproportionately single, and the ingestion was intentional in the large majority of cases, with women accounting for most suicidal ingestions and men for most accidental ones. This pattern consistent with caustic injury driven by psychosocial-distress in the young adult [2, 26–28]. By contrast, a more balanced sex distribution in caustic ingestion group seen in Asia and Egypt series [19, 29], possibly reflecting a greater share of accidental exposure in those cohorts, and easy access to caustic substances along with limited availability of mental health services may further contribute to the higher rates of intentional ingestion [30].

Non-caustic strictures predominantly affected older patients, consistent with the chronic nature of their common underlying conditions, including peptic injury and postoperative fibrosis, this finding consistent with reports from population-based data from the United Kingdom, where peptic strictures account for the majority of BES and typically present later in life [20], despite three fourth of patients had history of use of PPI. This does not necessarily indicate PPI failure, rather inconsistent adherence, under-dosing, delayed diagnosis, or fibrosis that had already progressed before treatment was started equally plausible explanations, and the retrospective design does not allow these possibilities to be distinguished.

The comorbidity gradient between groups, hypertension and anemia concentrated in the non-caustic group of BES reflects as a consequence of age and chronic disease rather than a mechanistic link to stricture formation [31]. Anemia was also somewhat more frequent in this group, potentially reflecting chronic mucosal inflammation, erosive esophagitis, or occult gastrointestinal blood loss, whereas relatively uncommon in caustic BES because stricture represent a healed fibrotic sequel of an acute injury, However, in the later stages of caustic BES, anemia is more likely attributable to malnutrition due to severe dysphagia [29].

Stricture morphology differed sharply by etiology: caustic injury produced multifocal, long-segment, proximal strictures, while distal strictures occurred exclusively in non-caustic disease, which is consistent with caustic agents causing diffuse panesophageal injury versus the anatomically localized nature of reflux damage [5, 9, 32, 33]. This anatomical separation of etiology alone offers a useful early indicator of expected procedural complexity [33, 34], however, the overlap between caustic and non-caustic etiologies across esophageal segments should be carefully considered, underscoring the need for a tailored endoscopic approach in the management of BES. Undetermined etiology accounted for 23% of non-caustic strictures (16% overall), comparable to some series from Australia and Nepal study [35, 36] though higher than recent studies that showed 0–5% [37, 38], given limited use of advanced imaging (chest CT in only six patients, lack of the use of endoscopic ultrasound) and absence of repeat biopsy in some patients, this likely reflects diagnostic-workup limitations rather than a truly distinct entity, and warrants continued vigilance for occult malignancy and esonophlic esophagitis.

The overall technical success rate of endoscopic dilation (ED) was 79%, lower than the 89–97% reported in some previous benign esophageal stricture cohorts [20]. However, comparisons should be interpreted cautiously, as technical outcomes are influenced by differences in stricture characteristics, case selection, procedural techniques, expertise, endoscopic and imaging resources. Clinical response, reflected by improvement or resolution of dysphagia, provides a more clinically meaningful patient centered measure of treatment effectiveness. Nearly two-thirds of patients managed exclusively with ED in our cohort achieved complete short-term symptomatic resolution. Although lower than the 80–90% response reported in some unselected BES cohorts [14, 39, 40], this outcome was comparable with reports among refractory BES populations [40–42], our cohort may reflect the challenging case mix, with an evidence that one-third of patients having refractory disease and a substantial burden of complex strictures requiring an average of more than five ED sessions.

The absence of a statistically significant difference in response between caustic and non-caustic strictures, despite their markedly different morphology, is therefore better explained by refractoriness, driven by stricture length, multiplicity, and fibrotic density, acting as a common final pathway to treatment failure that supersedes etiology once dilation is underway. This further supported by the higher median sessions per patients required (more than five sessions per patient) with no difference by etiology and patient response that align

with refractory-stricture series done in South Africa, Turkey, and Bahrain, where the median number of dilation reached 5–7.5 sessions per patient [17, 43, 44], and exceeds non-refractory cohorts from Korea and China [32, 45].

Regarding dilation technique, balloon dilation was the most frequently used modality, either alone or in combination with Savary–Gilliard bougie dilation with no significant difference in clinical response was observed between techniques across different cause. This finding consistent with a meta-analysis of five randomized controlled trials [46], retrospective study of 96 patients [47] and the 2018 UK guidelines [20], which report no meaningful difference in efficacy between the two techniques, though a recent 2025 Indian Society of Gastroenterology guidelines suggest that bougie dilators may be preferred for caustic esophageal strictures that further supported by large 17-year tertiary-center study reported bougie superiority in higher technical success, short-and long term clinical success [21, 48] a discrepancy in our cases likely explained by a differences in stricture etiology mix, anatomical characteristics, patient selection, and duration of follow-up may partly explain these apparently discrepant findings. Furthermore, our study may have been underpowered to detect modest differences between dilation techniques. According to the Indian Society of Gastroenterology guidelines, bougie dilation may be particularly suitable for relatively straight, long, or single strictures when appropriate expertise is available. Balloon dilation may offer advantages in patients with multiple strictures of varying caliber, complex or uncertain distal anatomy, or associated gastric cicatrization, where controlled and targeted dilation may be advantageous [21]. In clinical practice, the choice of dilation modality should be individualized according to stricture anatomy, available equipment, and operator expertise Sequential use of both techniques may also be considered when adequate luminal expansion cannot be achieved with a single modality.

The use of adjuvant intralesional steroid injection benefit observed here is directionally consistent with the current guideline recommendations that support corticosteroid injection primarily as an adjunctive intervention in appropriately selected patients with recurrent or refractory strictures rather than as routine first-line therapy [21] and prior reports in refractory strictures with different etiologies [42, 49, 50]. Further consolidated by some comparative studies have shown that significant dysphagia improvement and reduces the frequency of ED without increasing procedure-related complications [22, 42, 46], plausibly via inhibition of collagen cross-linking [45, 51] and, though this mechanism was not directly tested and durability beyond three months remains unproven as early gains have been reported to attenuate over time elsewhere [52, 53].

Despite successful endoscopic management in most patients, 21% ultimately required surgical intervention after failed endoscopic management, most often for strictures that remained refractory to repeated dilation. This proportion is higher than the roughly 11% surgical rate reported in a 15-year series of refractory strictures [9], a difference plausibly attributable to later presentation, more advanced fibrosis at first endoscopy, or more limited access to endoscopic rescue options such as temporary stenting in this setting, though the retrospective design cannot establish which of these contributed most. The absence of a significant difference in surgical requirement between caustic and non-caustic strictures in our cohort reinforcing that technical characteristics and stricture complexity, not etiology, drives failure of response. The overall complication rate (8.8%, including one procedure-related death) exceeded rates for simple peptic strictures less than 1% [46], but was comparable to refractory-stricture cohorts (4.2%) [24]; both perforations in this series occurred in caustic strictures, that had greater tissue friability and warranting a lower threshold for early recognition and escalation in such patients.

Several limitations warrant consideration. The retrospective nature of the study relied on the completeness of routinely recorded clinical documentation, introducing a risk of information bias and missing data (e, g length of stricture and the type and indication of previous surgery that leads to postoperative strictures), which was partially mitigated by telephone follow-up. The single-center setting limits generalizability to institutions with different referral patterns, resources, or access to surgical backup. Clinical response was assessed at three months, selected because this was the longest follow-up interval consistently documented across all patients. Telephone follow-up further suggested that many patients who discontinued follow-up after three months had experienced satisfactory clinical improvement, although this could not be objectively verified. Therefore, longer-term recurrence and durability of benefit, particularly following steroid injection, could not be reliably assessed. The modest

overall sample size, particularly in treatment subgroups, increased the possibility of type II error. Finally, dilation modality and steroid use were determined by clinical judgment rather than randomization, leaving the possibility of residual confounding by indication. A future research priority should be on prospective, multicenter designs with longer follow-up to evaluate the durability of steroid injection, identify predictors of treatment failure, and compare dilation techniques in BES of mixed etiologies.

Conclusion

Endoscopic dilation is a safe and effective treatment for benign esophageal strictures, with technical success achieved in approximately four-fifths of patients. Among patients successfully managed without subsequent surgical intervention, nearly two-thirds achieved a complete clinical response within three months. Short-term clinical outcomes achieved with comparable success across a mixed etiology of caustic and non- caustic BES including those with refractory disease. The use of adjuvant intralesional steroid injection was significantly associated with improved clinical response, though its durability remains unproven. Caustic and non-caustic strictures represent distinct clinical entities, differing in patient demographics, stricture anatomy, and underlying drivers of disease, that converge on a common treatment pathway once refractoriness sets in. Therefore, expanding of endoscopic dilation services and rational use of adjuvant steroid therapies with a tailored approach by recognizing stricture complexity and early complication in resource-limited setups could contribute to the improvement of outcomes in the sub-Saharan Africa region.

Abbreviations

BES	Benign Esophageal Stricture
ED	Endoscopic Dilation
EBD	Endoscopic Balloon Dilator
SGB	Savary–Gilliard Bougienage
GERD	Gastroesophageal Reflux Disease
PPI	Proton Pump Inhibitor
MMC	Mitomycin C
SPSS	Statistical Package for the Social Sciences

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Data availability No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate The study was reviewed and approved by the Institutional Review Board of Addis Ababa University College of Health Sciences (IRB reference number: 216/26), in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from participants prior to face-to-face interviews, and verbal informed consent was obtained prior to telephone interviews during the data collection period. Personal identifiers were not

used, and confidentiality was maintained throughout the study. Additional permission was obtained from the medical records unit of Tikur Anbessa Specialized Hospital for secondary data.

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