Title: Dilation or biodegradable stent placement for recurrent benign esophageal strictures: a randomized controlled trial

Short title: Dilation or biodegradable stent for BES

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Abbreviations:

BES	benign esophageal strictures
BD	biodegradable
AE	adverse events
SAE	serious adverse events
EQ	EuroQol
VAS	visual analog scale
WHO	World Health Organization
SEMS	self-expanding metal stents
FCSEMS	fully-covered self-expanding metal stents

ABSTRACT

Background and Study Aims: Dilation is standard of care for recurrent benign esophageal strictures (BES). Biodegradable (BD) stents may prolong the effect of dilation and reduce recurrences. Efficacy and safety of dilation and BD stent placement early in the treatment algorithm of recurrent BES were compared.

Patients and Methods: This multicenter, randomized study enrolled patients with BES treated with previous dilations to ≥16 mm. The primary endpoint was number of repeat endoscopic dilations for recurrent stricture within 3 and 6 months. Secondary outcomes through 12 months included safety, time to first dilation for recurrent stricture, dysphagia, and level of activity.

Results: At 3 months, the BD stent group (n=32) had significantly fewer endoscopic dilations for recurrent stricture compared to the dilation group (n=34; $p<0.001$). By 6 months, groups were similar. Number of patients experiencing adverse events was similar between groups. Two patients in the BD stent group died after developing tracheoesophageal fistulas at 95 and 96 days post-placement; no deaths were attributed to the stent. Median time to first dilation of recurrent stricture for the BD stent group was significantly longer (106 vs. 41.5 days, $p=0.003$). Dysphagia scores improved for both groups. Patients in the BD stent group had a significantly higher level of activity through 12 months ($p=0.0001$).

Conclusion: BD stent placement is associated with temporary reduction in number of repeat dilations and prolonged time to recurrent dysphagia compared to dilation. Additional studies are needed to better define the exact role of BD stent placement to treat recurrent BES.

Clinical Trial Registration: URL: https://www.clinicaltrials.gov/

Unique Identifier: NCT01337206

Keywords: esophageal stricture; dysphagia; biodegradable stents; endoscopic procedures

INTRODUCTION

Benign esophageal strictures (BES) occur following peptic, corrosive or radiation injury, surgical anastomosis, post-mucosal resection, or esophageal inflammatory disease.[1-3] Dysphagia is a frequent symptom for these patients, resulting in an inability to eat a normal diet leading to malnutrition, weight loss, aspiration, and impaired quality of life.[4,5]

The primary treatment for BES is endoscopic dilation with balloon or bougie dilators. While dilation relieves dysphagia in the majority of patients with BES, repeated sessions, which are a burden to patients and increase health care costs,[5,6] are frequently required.[7-9] Temporary stent placement, which dilates the stricture for a prolonged period of time and may lead to a reduction of stricture recurrence,[10,11] is a potential treatment for patients refractory to ongoing dilation. Partially- and fully-covered self-expandable stents require additional endoscopic procedures for removal and are prone to tissue ingrowth or migration.[11-14]

To address these problems, biodegradable (BD) stents have been designed as a promising alternative. To reduce the risk of migration, the BD stent has flared ends and is uncovered, allowing for tissue ingrowth. Stent integrity and radial force are typically maintained for up to 8 weeks and considerable stent degradation is expected approximately 12 weeks following placement.[15-18] A recent study reported a median time to complete stent degradation of 127 days (range: 98-219 days).[19] Because the BD stent degrades, removal is not required. Experience with BD stents is limited to small case series of patients with refractory strictures.[15-20] No studies have evaluated whether BD stents placed earlier in the treatment algorithm could be an effective alternative to reduce the risk of recurrent dysphagia. This study compared the efficacy and safety of standard dilation and BD stent placement in patients with recurrent BES.

METHODS

Study Design

Between 2012 and 2015, a multicenter, randomized controlled trial compared dilation therapy to BD esophageal stent placement in patients with BES. Patients with confirmed recurrent BES, a dysphagia score ≥2 on the Ogilvie scale[21] and ≤21 on the Dakkak and Bennett scale[22] (Supplementary Table 1), and a history of one to five previous endoscopic dilations to ≥16 mm within the prior year were eligible. Key exclusion criteria included a surgical or interventional procedure in the esophagus 30 days prior to or after the procedure; previous esophageal stent placement or dilation method other than standard bougie or balloon; stricture within 1.5-cm of the upper esophageal sphincter; lesions requiring more than one stent; stricture length ≥10-cm; active esophageal perforation, leak, fistula, or varices; highly suspected esophageal malignancy; and known eosinophilic esophagitis or motility disorder. Approval was obtained by each site's ethics committee, and patients provided written informed consent. Permuted block randomization, using a centralized computer system, randomized patients in a 1:1 ratio to standard dilation therapy or BD stent placement. The study was not blinded.

Dilation and stent placement procedure

At the physician's discretion, patients were placed under sedation prior to endoscopic procedures. A balloon or bougie was used for dilation according to standard institutional practice to reach a target diameter of ≥16 mm. Stepwise dilation was permitted at the physician's discretion when a single session was considered unsafe. The target diameter had to be reached within 2 weeks. Endoscopy confirmed dilation efficacy and assessed for potential perforation. In the stent group, pre-dilation was allowed prior to the endoscopic placement of a BD stent (SX-ELLA, Ella-CS, Czech Republic) made of polydioxanone, a

biodegradable synthetic polymer. Based upon initial stricture assessment, the appropriate stent length (60, 80, or 100 mm) and stent diameter (18, 20, or 23 mm) was placed under fluoroscopy. Endoscopy confirmed correct stent positioning, by visualizing the radiopaque markers, and expansion across the stricture (Figure 1). Patients in both groups used a proton pump inhibitor according to standard of care.

Patient follow-up

Patients were contacted by telephone 14 days, monthly through 6 months, and 12 months after treatment. At 3 months, patients in the stent group underwent a radiographic evaluation of the esophagus to visualize the gold markers. For those patients with visible gold markers at 3 months, radiography was performed again at 6 months. With the exception of this radiographic evaluation in patients with a BD stent, the follow-up schedule was comparable between groups. Reintervention for recurrent significant dysphagia, defined as a dysphagia score ≥2 on the Ogilvie scale[21] or ≤21 on the Dakkak and Bennett scale,[22] was performed at the physician's discretion. When recurrent significant dysphagia within 6 months of the initial procedure (defined in the dilation group as the procedure in which the final target diameter was reached) occurred in either group, standard dilation up to 18 mm was performed. When recurrent significant dysphagia occurred after 6 months, all treatment options were available.

Study endpoints

The primary endpoint was the number of repeat endoscopic dilations for recurrent stricture within 3 months and 6 months after stent placement or dilation to ≥16 mm. Recurrent stricture was defined as any apparent stricture in patients presenting with dysphagia for at least solid food. Secondary outcomes through 12 months included safety, freedom from dilation for recurrent stricture, time to first dilation for recurrent stricture, freedom from endoscopic

procedures, time to first endoscopy, dysphagia, quality of life, and level of activity. Safety was reported as the number of non-serious adverse events (AE) and serious adverse events (SAE). Dysphagia was assessed using the Ogilvie[21] and Dakkak-Bennett[22] scales (Supplementary Table 1). Time to recurrent significant dysphagia was the number of days from the initial procedure to onset of recurrent dysphagia for at least solid food. Quality of life was assessed using the EuroQol (EQ)-5D-3L, which includes five questions related to health status (Supplementary Table 1), and a self-reported visual analog scale (VAS).[23] Collectively, responses to the five questions comprise the composite score. A patient records their level of health on a vertical VAS, where the endpoints are labeled "best imaginable health state" and "worst imaginable health state". Level of activity was assessed using the World Health Organization (WHO) performance score (Supplementary Table 1). Presence of gold markers (BD stent group only) was assessed by radiography.

Statistical analysis

The Signorini method[24] was used to calculate sample size, and the Holm–Bonferroni method[25] was used to correct for multiple comparisons with two primary hypotheses (i.e., 3 months and 6 months). A Poisson rate of one dilation per patient in 12 weeks in the BD stent group and a Poisson rate of two dilations per patient in 12 weeks in the dilation group was assumed. Sample size calculations resulted in a total sample size of 60 patients with a power of 0.935. To compensate for a 10% loss to follow-up, the study enrolled a total of 66 patients.

Continuous variables were expressed as means (± SD) or medians (IQR and range). Categorical data were presented with percentages. The t-test was used to analyze normally distributed continuous data; the Mann-Whitney U test analyzed non-parametric data; the exact Cochran-Armitage test for trend analyzed baseline Ogilvie scores; and either the Chi-square

test or Fischer's exact test was used for categorical variables. Kaplan-Meier analysis was performed to determine freedom from dilation for recurrent stricture, with the *p*-value calculated using the log-rank test. For dysphagia scores, EQ-5D-3L with the self-reported VAS, and WHO performance scores, means were plotted over time with vertical lines representing the 95% confidence interval. A linear mixed model regression analysis that included follow-up time (continuous, in months), treatment group, and the interaction between follow-up and treatment group corrected for baseline measurements was used to determine differences between treatment groups while controlling for time. A *p*-value of <0.05 was considered to be statistically significant.

RESULTS

Thirty-two patients were randomized to BD stent placement (BD stent group), and 34 patients were randomized to standard dilation therapy (dilation group, Figure 2). All patients received the assigned treatment. Baseline characteristics were similar between groups (Table 1). The majority of patients in both groups had anastomotic strictures. Prior to stent placement, 11 patients in the BD stent group had pre-dilation up to 16 mm. All stents were successfully placed at the intended location during the initial procedure.

Primary endpoint: Dilation for recurrent stricture

At 3 months, the BD stent group had significantly fewer therapeutic endoscopic dilations for recurrent stricture compared to the dilation group (median: 0 vs. 1, $p<0.001$; Figure 3A). By 6 months, there was no difference between groups (median: 1 vs. 1, $p=0.31$; Figure 3B).

Mortality and safety

The non-serious AEs and the SAEs are shown in Table 2. There was no difference ($p=0.42$) in the number of patients experiencing AEs between groups. The most common AE was

recurrent significant dysphagia requiring intervention. In the dilation group, two patients experienced perforations. In the BD stent group, patients experienced stent occlusion (n=5), tracheoesophageal fistula (n=2), and stent migration (n=1). Eight patients died during the study; none of the deaths were attributed to the study stent by the study sites. In the dilation group, deaths were due to progression of underlying disease (i.e., prior cancer diagnosis; n=3). In the BD stent group, deaths were due to progression of underlying disease (i.e., prior cancer diagnosis; n=3) and to respiratory insufficiency and infection subsequent to tracheoesophageal fistula (n=2). One fistula was identified 95 days after initial stent placement and 7 days after placement of a second, larger, non-study BD stent. The second fistula, which was located in an area previously treated by radiotherapy, was identified 96 days after initial stent placement. Subsequently, the patient had multiple surgical interventions, including trachea repair, thoracotomy, tracheal stent placement, and tracheostomy. Both patients subsequently died due to respiratory insufficiency and infection.

Secondary outcomes

The BD stent group had a higher rate of freedom from dilation for recurrent stricture compared to the dilation group at 3 months (87.5% vs. 49.5%), which was sustained through 6 months (48.4% vs. 34.1%) and continued through 12 months (40.8% vs. 27.9%, log-rank p=0.05; Figure 4A). The median time to first dilation of recurrent stricture for the BD stent group was significantly longer than the dilation group (106 and 41.5 days, p=0.003; data not shown).

Some patients underwent procedures other than dilation for recurrent stricture, such as for removal of food bolus obstruction or for evaluation of retrosternal pain. The BD stent group had a higher rate of freedom from endoscopic procedures compared to the dilation group at 3 months (50.0% vs. 32.4%), although the overall number of endoscopic procedures per

patient at 3 months was similar between groups (median: 0.5 vs. 1, p=0.21). The differences in freedom from endoscopic procedures between groups decreased through 6 months (30.1% vs. 23.5%) and 12 months (26.3% vs. 17.6%, log-rank p=0.26). The median time to first endoscopy was also similar between groups (44 and 28 days, p=0.54).

Both groups had significantly improved Ogilvie and Dakkak-Bennett dysphagia scores at 3 months, 6 months, and 12 months compared to baseline (p<0.001 for all time points). These improvements did not differ between groups (p=0.68; Figure 5A, and p=0.89; Figure 5B).

Through 12 months, the groups were similar for the EQ-5D composite score (p=0.57; Figure 6A). However, patients in the BD stent group reported a significantly better quality of life through 12 months than patients in the dilation group based on the EQ-5D VAS (p=0.01; Figure 6B). Level of activity, measured with the WHO performance score, for patients in the BD stent group was significantly better than the level of activity for patients in the dilation group through 12 months (p=0.0001; Figure 6C). Patients in the BD stent group had significantly improved WHO performance scores compared to baseline at 6 months (p=0.001) and 12 months (p<0.05).

Gold markers were visible in 25 of 29 patients (86%) evaluated in the BD stent group at 3 months. By 6 months, gold markers were visible in four of 23 patients (17%). No adverse events related to passing or retention of the gold markers were reported.

DISCUSSION

Frequent repeated endoscopic dilations, which are considered a burden to patients and increase health care costs,[5,6] are one of the main reasons to identify an alternative treatment for patients with BES. Initial reports of BD stent placement for BES had disappointing results;

however, the more recently available polydioxanone BD stent has resulted in increased placement of BD stents.[15-19] In the current study, patients in the BD stent group had fewer repeat dilations for recurrent stricture within the first 3 months. Furthermore, patients in the BD stent group had a significantly longer time to first dilation of recurrent stricture. After the first 3 months, which is approximately the time the stent degrades, the number of dilations for recurrent dysphagia increased in the BD stent group, and by 6 months, the total number of dilations in both groups was comparable. The total number of endoscopic procedures was not different after 3 months because a number of patients in the BD stent group presented with retrosternal pain, nausea, and vomiting requiring diagnostic endoscopy. This type of AE has previously been reported in patients with BD stents and esophageal self-expanding metal stents (SEMS).[16] Events related to retrosternal pain in prior studies have been reported with use of larger diameter BD stents (e.g., 25 mm).[16,17] Stent stiffness and an inflammatory response in the esophageal mucosa may explain these events.[16,26] Taken together, our results suggest that BD stent placement may provide a temporary benefit to patients with recurrent BES.

Both groups had significantly improved dysphagia scores, although the study did not correlate the timing of the most recent dilation to dysphagia scores or reinterventions. Through 12 months, the BD stent group reported a significantly better overall health status as measured by the EQ-5D VAS. However, there was no difference between groups on the EQ-5D composite score. The EQ-5D composite score allows the patient to choose from three specific statements in each of the five areas, whereas health state is measured with a VAS, which reflects the overall perception of health status and may be influenced by factors unrelated to the specific measures assessed by the EQ-5D. Within the BD stent group, the WHO performance score significantly improved compared to baseline; however, no difference was seen in the dilation group. Through 12 months, the BD stent group showed a significantly

higher level of activity as measured by the WHO performance score than the dilation group. Potential limitations to the current study are that quality of life measures were not assessed immediately prior to or after a reintervention, and the timing of the evaluation in relation to other interventions was not identified. The observed differences in quality of life between groups may be related to the sensitivity of the respective scores within this relatively small population or potential confirmation bias associated with group assignment.

In this study, the number of patients experiencing AEs was not different between groups; the most common event reported was recurrent significant dysphagia requiring intervention. In the dilation group, the number of SAEs was considerably higher than previously reported.[11,27] The reported rate for laceration and/or perforation following dilation ranges from 0.1% to 3%,[11.27] compared to 9% in this study. Notably, one of the two perforations developed after placement of a fully-covered SEMS (FCSEMS) for a reintervention at 154 days post-procedure, which highlights that caution should be exercised in this patient population. The second perforation developed during the initial dilation procedure in a patient with a tortuous and narrow esophageal stricture, which is known to have a higher risk for perforation.[11]

Another known risk associated with treating BES is esophagorespiratory fistula formation in patients with esophageal stents. In this study, two patients treated with a BD stent developed a tracheoesophageal fistula approximately 3 months after initial BD stent placement and later died. In the case where a second, larger non-study BD stent was placed, the larger stent may have contributed to local tissue damage. In the second case, the fistula was identified in an area where the patient had received radiation treatment for esophageal squamous cell carcinoma; the stent was no longer visible. Radiotherapy in combination with initial radial force from the stent may have contributed to fistula formation. Development of a

tracheoesophageal fistula after BD stent placement for a refractory BES has been reported previously.[19,28] In a recent study, an esophagobronchial fistula was reported approximately 3 months following placement of a BD stent in a patient with a history of endoscopic submucosal dissection and chemoradiotherapy with repeated endoscopic balloon dilation for refractory BES.[19] The authors suggest caution with use of a BD stent for patients with prior esophageal radiation treatment.[19]

FCSEMS are another option for treating BES, but these stents have known complications. Esophagorespiratory fistulas have been reported with use of SEMS for benign (13.6%) and malignant (8.5%) strictures of the proximal and middle esophagus.[29] Because FCSEMS are non-degradable stents that require endoscopic removal, BD stents were developed as an alternative. The radial force of the BD stent is typically maintained for up to 8 weeks and decreases over time as the stent degrades.[16,18] A flexible stent that has a lower axial force may be preferred; however, no other BD stent designs are currently available. Another well-known complication with FCSEMS is stent migration. In this study, only one partial migration occurred in the BD stent group.

Studies evaluating BD stent placement that include patients with refractory BES have reported a mean clinical success rate of 39%,[20] which is similar to the rate of freedom from endoscopic dilations for recurrent stricture through 12 months in the BD stent group in this study. Only one randomized study has compared BD stent placement to balloon dilation in patients with BES.[26] However, the study was prematurely closed due to low enrollment; therefore, the study lacked adequate power to determine any statistical differences in dysphagia scores or draw any clinically relevant conclusions. The current study was also challenged by slow patient accrual despite enrollment at eight institutions.

Because the pathogenesis of BES varies, some types of stricture may benefit more from BD stent placement than others, and placement of a BD stent at first presentation with a BES, at least in a subgroup of patients, may have a greater impact. In this study, most patients presented with anastomotic stricture, suggesting applicability to BES with alternate etiology (such as ingestion of caustic substances) may be limited. Furthermore, patients with at least one and a maximum of five previous dilations to ≥16 mm were included to assure stent placement with a minimum diameter of 18 mm was justified with a balanced risk of procedure-related complications.

Radiographic visibility of the gold markers served as a surrogate for assessing stent integrity, with the assumption that if the gold markers were not visible, then the BD stent had degraded. By 6 months, gold markers were not visible in the majority of evaluable patients. The timing of stent degradation appears to correspond to the two groups being similar in number of endoscopic dilations for recurrent stricture by 6 months.

There are several limitations to this study. Patients were not blinded to treatment. The type of dilator used by trained physicians was not standardized across the study. Instead, dilation with a balloon or a bougie was performed according to standard institutional practices to reach the target diameter of ≥16 mm. In addition, the study did not require a specific algorithm for dilating patients with recurrent stricture after study inclusion. For these patients, dilation was performed per institutional guidelines. Neither dysphagia scores nor quality of life measures were taken prior to reintervention.

In conclusion, BD stent placement for recurrent BES is associated with a temporary reduction in the number of repeat dilations and a prolonged time to recurrent dysphagia compared to standard dilation. In general, patients in the BD stent group had improved dysphagia scores

and higher level of activity. While there was no difference in number of endoscopic dilations for recurrent strictures between groups by 6 months, the BD stent did provide short-term benefits in patients with recurrent BES, with the majority being anastomotic strictures. Due to the potential risk of complications, caution should be used when placing a BD stent in patients with prior esophageal radiation treatment. Additional studies are needed to better define the role and the long-term benefit of the BD stent in the treatment of recurrent BES in other subgroups of patients. As the pathogenesis of BES differs, some types of strictures may benefit more from BD stent placement than others.

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462 **Supplementary Table 1. Scoring method definitions**

Scale	**Score**	
Ogilvie dysphagia	0: Able to eat a normal diet 1: Able to eat some solid food 2: Able to eat some semi-solid food only 3: Able to swallow liquids only 4: Inability to tolerate any oral intake	
Dakkak-Bennett dysphagia	1: Able to swallow water 2: Able to swallow milk 3: Able to swallow custard 4: Able to swallow jelly 5: Able to swallow scrambled eggs 6: Able to eat baked fish 7: Able to eat white bread 8: Able to eat an apple 9: Able to eat steak 45 Total	
EQ-5D questionnaire	Mobility	1: I have no problems in walking about 2: I have some problems in walking about 3: I am confined to bed
	Self-care	1: I have no problems with self-care 2: I have some problems washing or dressing myself 3: I am unable to wash or dress myself

	Usual activities	1: I have no problems with performing my usual activities 2: I have some problems with performing my usual activities 3: I am unable to perform my usual activities
	Pain/Discomfort	1: I have no pain or discomfort 2: I have moderate pain or discomfort 3: I have extreme pain or discomfort
	Anxiety/Depression	1: I am not anxious or depressed 2: I am moderately anxious or depressed 3: I am extremely anxious or depressed
WHO performance	0: Normal activity without restriction 1: Strenuous activity restricted, can do light work 2: Up and about >50% of waking hours, capable of self-care 3: Confined to bed >50% of waking hours, limited self-care 4: Confined to bed or chair, no self-care, completely disabled	

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Table 1. Patient demographics and lesion characteristics

			Dilation (n)	**Stent (n)**	***p*-value**
Patients/lesions			34	32	-
Age, years (mean ± SD)			62 ± 12	62 ± 9	0.91
Males, %			77% (26)	66% (21)	0.42
Lesion length, cm (median (n, Q1-Q3, IQR, Min-Max))[a]			1 (33, 0.5-2, 1.5, 0.2-7)	1 (26, 1-2, 1, 0.2-7)	0.77
Diameter of stricture	Mild (>9.8 mm)		27% (9)	34% (11)	0.59
	Narrow (≤9.8 mm)		74% (25)	66% (21)	
Morphology of stricture	Anastomotic stenosis		77% (26)	72% (23)	0.43
	Caustic stenosis		6% (2)	3% (1)	
	Peptic stenosis		9% (3)	3% (1)	
	Other[b]		9% (3)	22% (7)	
Dysphagia score	Dakkak-Bennett (median (n, Q1-Q3, IQR, Min-Max))		15 (34, 10-21, 11, 0-21)	15 (32, 10-21, 11, 3-21)	0.93
	Ogilvie	0	0% (0)	0% (0)	0.61
		1	0% (0)	0% (0)	
		2	79% (27)	69% (22)	
		3	18% (6)	31% (10)	
		4	3% (1)	0% (0)	

[a] Lesion length not recorded for all patients

[b] EMR/ESD contributed to all three strictures in the dilation group and 5/7 strictures in the stent group.

468 EMR, endoscopic mucosal resection; ESD, endoscopic submucosal dissection

469 **Table 2. Adverse events**

		Non-serious		Serious[a]	
Event Category		**Dilation**	**Stent**	**Dilation**	**Stent**
Gastrointestinal	Clinical signs/symptoms[b]	11	6	0	5
	Recurrent significant dysphagia requiring intervention	86	71	0	0
	Occlusion	0	5	0	0
	Perforation	0	0	2	0
	Migration	0	0	0	1
	Recurrent significant dysphagia requiring intervention requiring hospitalization	0	0	2	3
	Miscellaneous GI event[c]	10	17	5	2
Pulmonary	Tracheoesophageal fistula	0	0	0	2
	Miscellaneous pulmonary event[d]	4	3	2	2
Cardiovascular		1	0	1	1
Neurologic		1	0	1	1
Orthopedic		0	2	0	0
Renal/Urologic		1	1	1	0
Vascular		0	0	0	1
Access site/incision		0	0	0	1
Oncology		0	0	4	3
Miscellaneous non-GI event		11	3	1	1
Total adverse events		125	108	19	23

[a] An SAE was defined as an adverse event that led to death, a serious deterioration in the health of the subject resulting in a life-threatening illness or injury or a permanent impairment of a body structure or body function, required in-patient hospitalization or prolongation of existing hospitalization, resulted in medical or surgical intervention to prevent permanent impairment to body structure or body function, or led to fetal distress, fetal death, a congenital abnormality, or birth defect.

[b] Patients may have more than one clinical sign or symptom, which included abdominal pain, nausea, and/or vomiting, as well as retrosternal pain, heartburn, loss of appetite, regurgitation, and hematemesis.

[c] Serious miscellaneous GI adverse events in the dilation group included esophageal laceration (n=1), new symptoms requiring hospitalization (n=1), hyperplasia (metal stent, n=1), and follow-up treatment for other condition requiring hospitalization (n=2). Serious miscellaneous GI adverse events in the stent group included peritonitis with liver abscess (n=1) and new symptoms requiring hospitalization (n=1).

[d] Serious miscellaneous pulmonary adverse events in the dilation group included pneumonia (n=2). Serious miscellaneous pulmonary adverse events in the stent group included pneumonia (n=1) and respiratory insufficiency (n=1).

FIGURE LEGENDS

Figure 1. Biodegradable stent. (A) Image of the SX-ELLA stent, with radiopaque markers, made of biodegradable polydioxanone. Stents are available in multiple lengths (6, 8, or 10 cm) and diameters (18, 20, or 23 mm). (B) Endoscopic image of the BD stent placed across a BES.

Figure 2. Patient flow diagram. Enrollment by original assignment and follow-up through 12 months are shown.

Figure 3. Endoscopic dilation for recurrent stricture. (A) The BD stent group (red bar) had significantly fewer endoscopic dilations for recurrent stricture compared to the dilation group (blue bar) at 3 months ($p<0.001$). (B) The number of endoscopic dilations for recurrent stricture between groups was similar by 6 months ($p=0.31$). The table shows median values (Q1-Q3, IQR [inner quartile range], Min-Max). Median values are represented by lines; mean values are represented by circle or plus symbols; top whisker by the third quartile (Q3) plus 1.5 times the IQR (IQR = Q3-Q1); and bottom whisker by Q1 minus 1.5 times IQR.

Figure 4. First dilation of recurrent stricture. (A) Kaplan-Meier estimates for freedom from dilation for recurrent stricture show that the BD stent group (red dashed line) had a higher rate compared to the dilation group (blue solid line) at both 3 months and 6 months. The groups were similar at 12 months ($p=0.05$). (B) The median time to first dilation of recurrent stricture for the BD stent group (red bar) was significantly longer than the dilation group (blue bar, $p=0.003$). Median values are represented by lines; mean values are represented by circle or plus symbols; top whisker by the third quartile (Q3) plus 1.5 times the IQR (IQR = Q3-Q1); and bottom whisker by Q1 minus 1.5 times IQR. Only those patients with an event were included in the analysis.

Figure 5. Dysphagia scores over time. Mean dysphagia scores were plotted over time using (A) the Ogilvie dysphagia scores for the dilation group (blue dashed line) and the BD stent group (red solid line) and (B) the Dakkak-Bennett dysphagia scores for the dilation group (blue solid line) and the BD stent group (red dashed line). Patients in the groups were similar through 12 months using either the Ogilvie (p=0.68) or Dakkak-Bennett (p=0.89) dysphagia scores. Vertical lines represent the 95% confidence interval for the mean at each time point.

Figure 6. Quality of life scores over time. (A) The mean EQ-5D composite scores, (B) the mean EQ-5D VAS scores, and (C) the mean WHO performance scores for the dilation group (blue dashed line) and the BD stent group (red solid line) were plotted over time. (A) Through 12 months, the groups were similar (p=0.57). (B) Patients in the BD stent group reported a significantly better quality of life through 12 months compared to patients in the dilation group (p=0.01). (C) The BD stent group had a significantly higher level of activity compared to the dilation group through 12 months (p=0.0001). Vertical lines represent the 95% confidence interval for the mean at each time point.

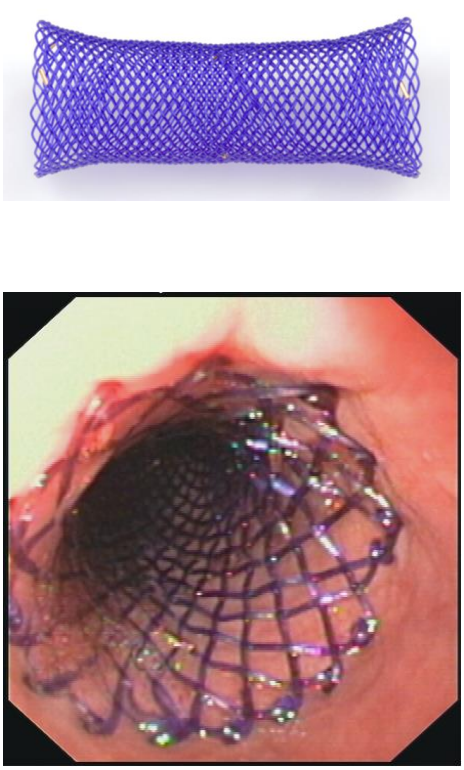

Figure 1. Biodegradable stent.

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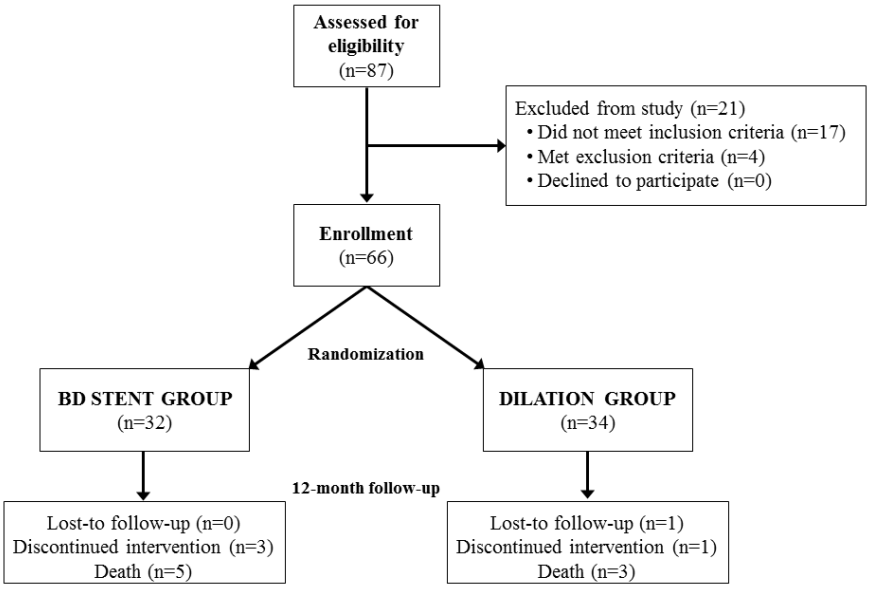

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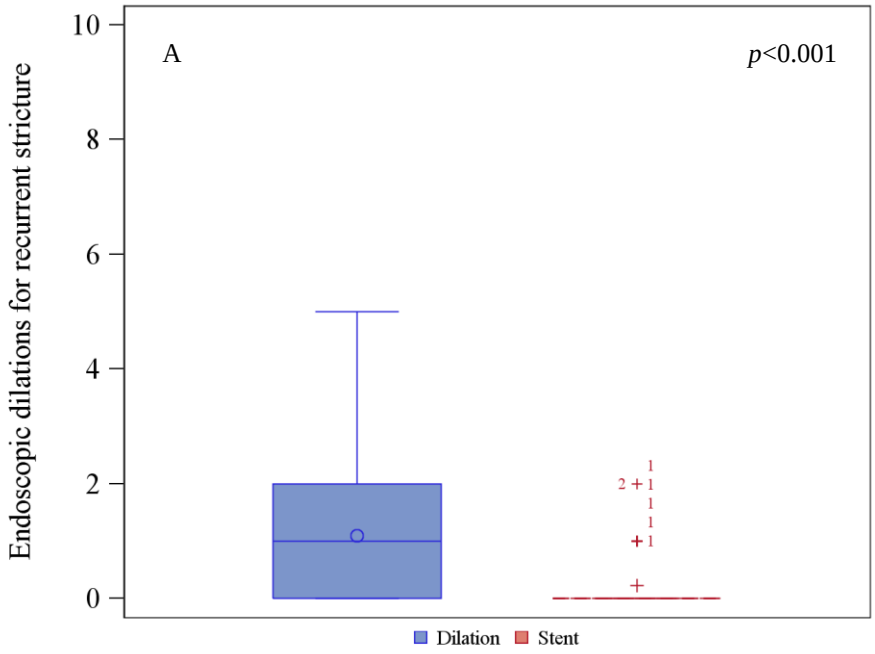
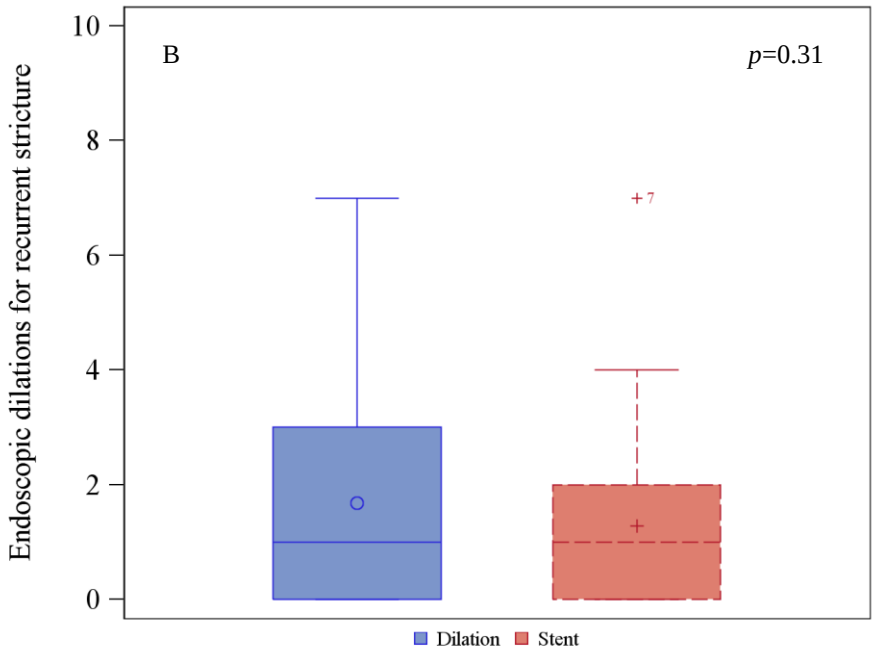
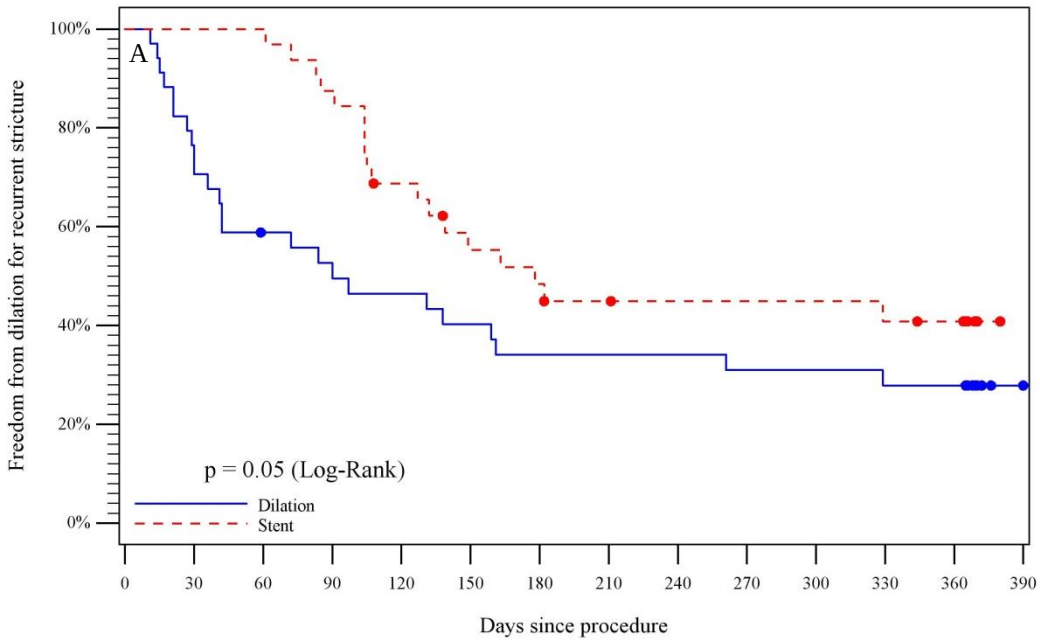
537 **Figure 2. Patient flow diagram.**





Median number of endoscopic dilations for recurrent stricture	Dilation (n = 34)	Stent (n = 32)	p-value
Within 3 months	1 (0-2, 2, 0-5)	0 (0-0, 0, 0-2)	<0.001*
Within 6 months	1 (0-3, 3, 0-7)	1 (0-2, 2, 0-7)	0.31

Figure 3. Endoscopic dilation for recurrent stricture.



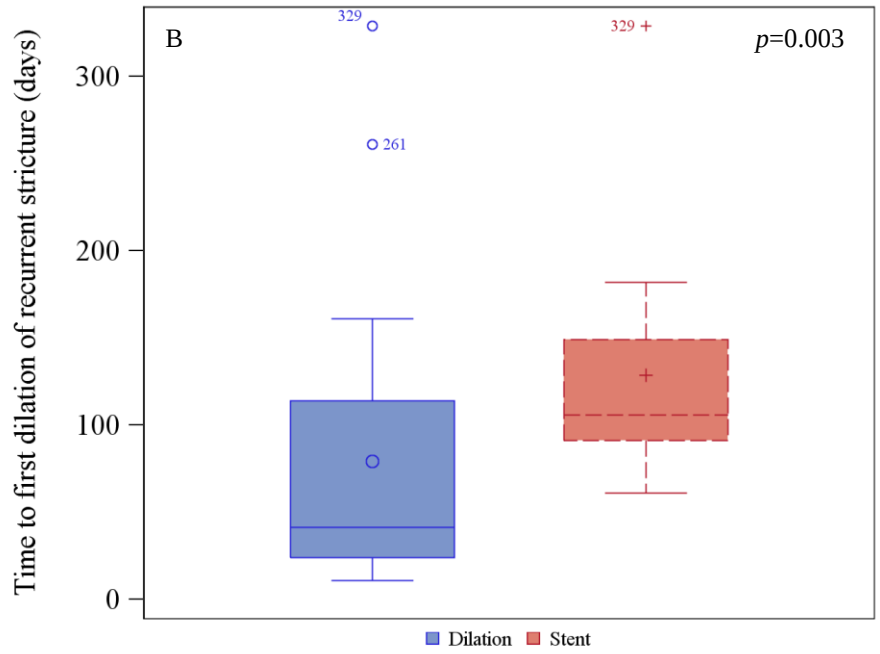


Figure 4. First dilation of recurrent stricture.

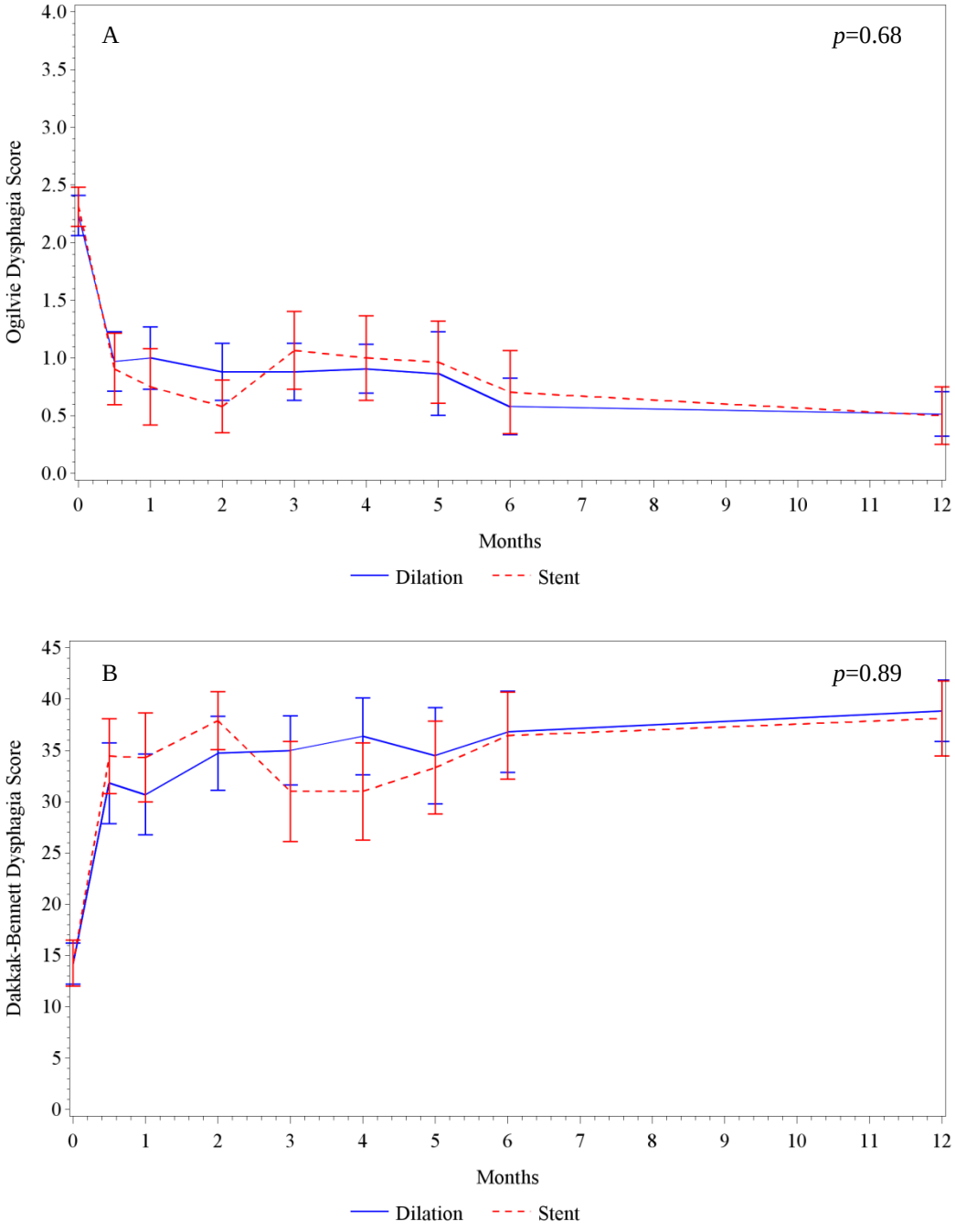
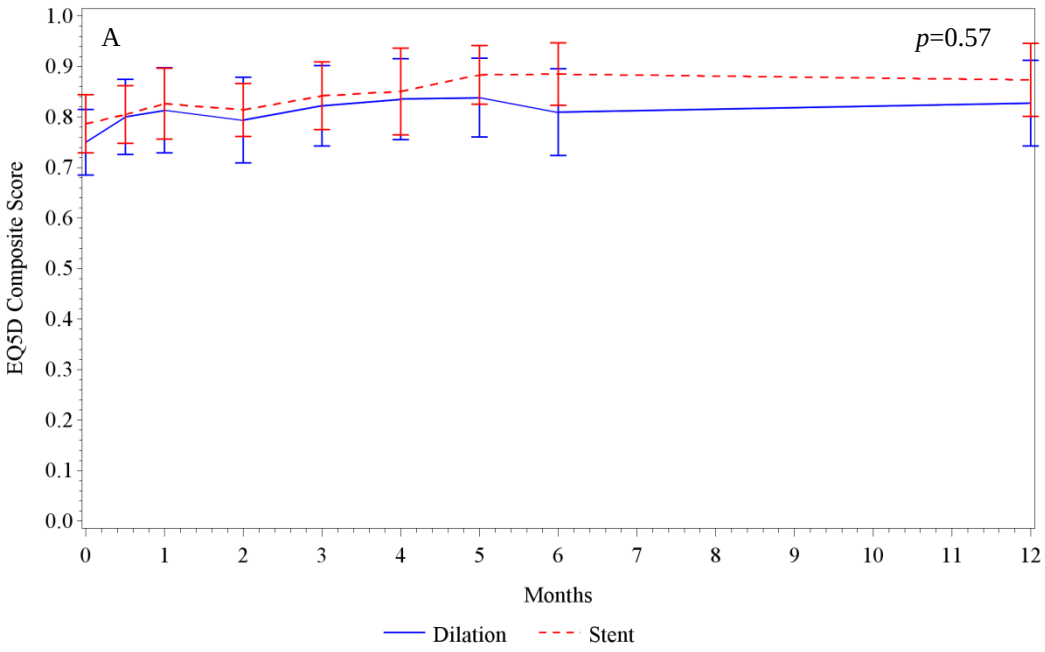


Figure 5. Dysphagia scores over time.



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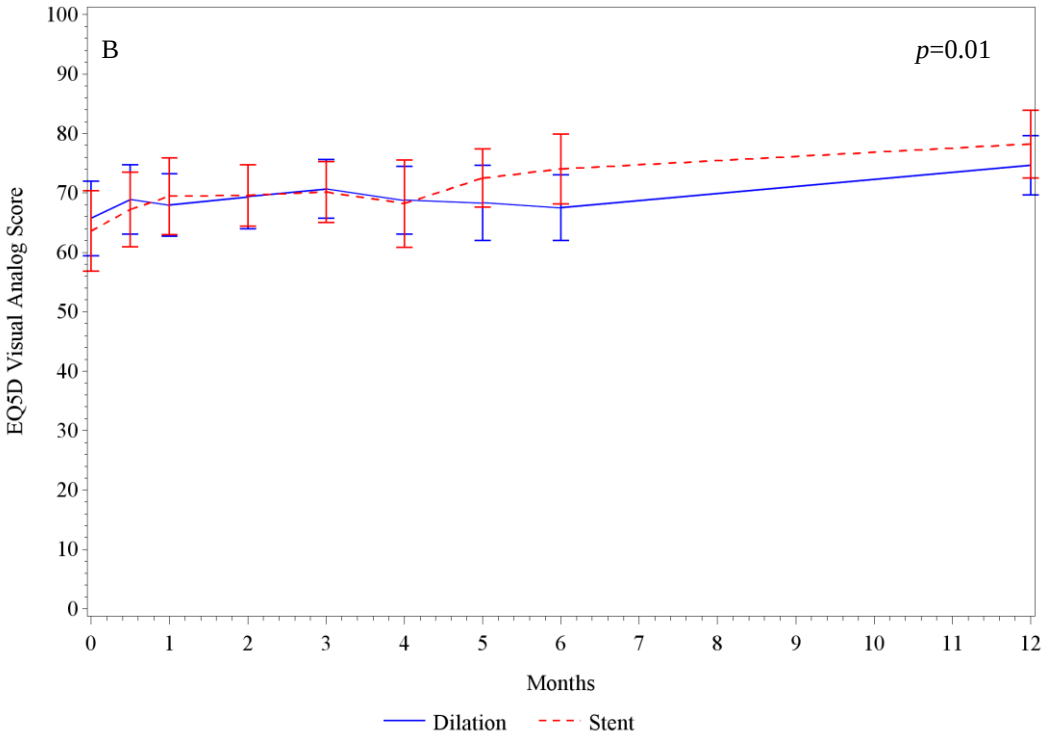

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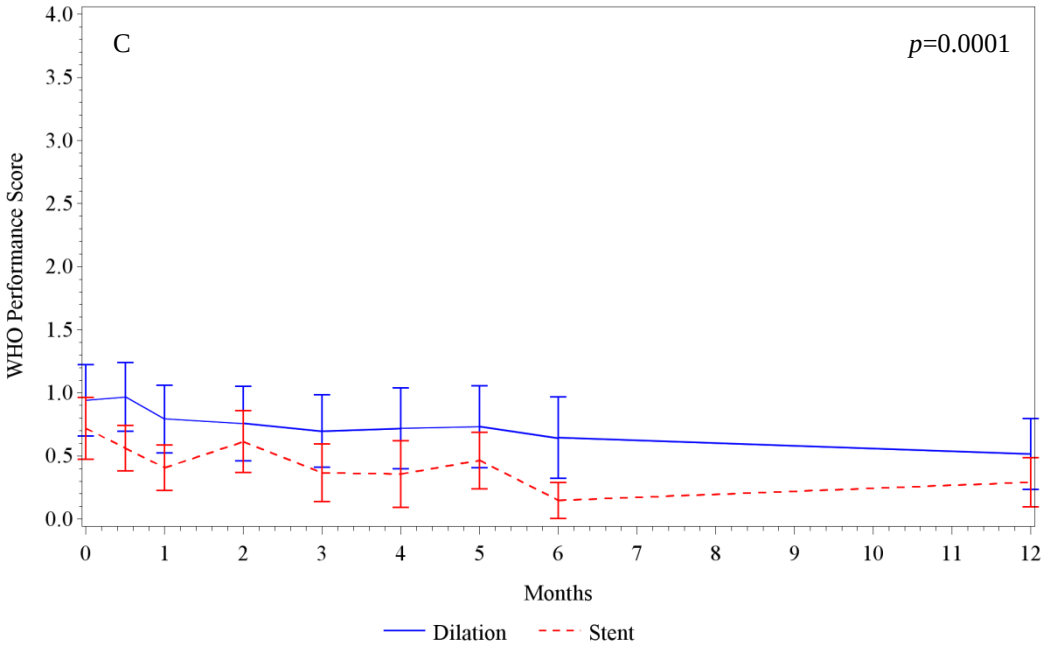

Figure 6. Quality of life scores over time.