balloon inflation, were quite similar among different centers. Furthermore, we were not able to exclude publication or reporting bias so that patients in whom dilation therapy could not be technically performed may have been under-represented in available publications. The retrospective noncontrolled observational nature of the study did not allow randomization based on risk factors or other criteria. Finally, the time point of evaluation of clinical efficacy was not standardized across studies. However, clinical efficacy was measured closely to dilation in all cases because symptom relief occurs almost immediately postprocedure. According to the Cochrane risk of bias tool, our study carries all potential inherent biases of cohort studies with retrospective data collection. In addition, reporting bias may apply because our study was a pooled analysis of already published studies. Centers with poor outcomes or high complication rates may not publish their cases. However, the largest published study included in this investigation by Singh et al[16] included all dilations performed at this tertiary center. Finally, because we have incomplete data for some variables and outcomes attrition, bias may apply. However, of the 39 items assessed for patient characteristics, stricture characteristics, and outcome, 29 items were available in 85% of included patients or more. In particular, short- and long-term outcome parameters were available for the vast majority of patients.

Although our study adds important information to the literature, from a clinical point of view, our study cannot fully answer the question about which patients are treated best by EBD and which by surgical intervention. This clinical dilemma would require a head-to-head trial of the 2 modalities. The main value of this investigation lies in providing practicing providers with robust data for informed decision making in patients with upper GI CD.

Taken together, the results of this large multicenter evaluation of EBD for CD-associated strictures of the upper GI tract show high rates of short-term technical and clinical success. Given the moderate long-term efficacy and acceptable complication rate, EBD is a valuable treatment option in patients with stricturing CD of the upper GI tract when contraindications such as abscess, fistula, phlegmon, dysplasia, or malignancy have been excluded.

Supplementary Material

Note: To access the supplementary material accompanying this article, visit the online version of *Clinical Gastroenterology and Hepatology* at www.cghjournal.org, and at https://doi.org/10.1016/j.cgh.2018.11.048.

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Reprint requests
Address requests for reprints to: Dominik Bettenworth, MD, Department of Medicine B, Gastroenterology and Hepatology, University Hospital Münster, Albert-Schweitzer-Campus 1, D-48149 Münster, Germany. e-mail: dominik.bettenworth@ukmuenster.de; fax: (49) 251-83-47570.

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The authors disclose no conflicts.

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Supplementary Materials and Methods

Statistical Analysis

Individual patient data meta-analysis was performed using a 1-step approach in which data from all studies were modeled simultaneously. Summary data were obtained using survey methodology, with study as a clustering effect. In addition, regression accounts for correlations between subjects within the same study as well as multiple dilations for the same patients. Complete-case analysis was performed.

Short-term clinical efficacy. Dilation-level data were used to assess factors associated with clinical efficacy using generalized linear mixed models with a logit link for binary data; random effects for center, study, and subject were used to account for correlation between multiple dilations performed on the same patient and between patients seen at the same center. Only an unadjusted analysis was performed because fewer than 20 dilations did not achieve clinical efficacy.

Redilation and recurrence of symptoms. Dilation-level data were used to assess factors associated with recurrence of symptoms and need for redilation. Some dilations did not have follow-up information on either redilation or symptom recurrence and were excluded from this part of the analysis. To assess redilation, follow-up time was defined as months from current dilation to time of redilation; subjects were censored at the time of last follow-up visit if they had no redilations. Symptom recurrence was assessed only in subjects with clinical efficacy, and follow-up time was defined as months from the current dilation to time of symptom recurrence; subjects were censored at the time of redilation, surgery, or last follow-up visit if they had no recurrence. Cox marginal model regression analysis was performed and standard errors and *P* values are based on a robust (sandwich) variance estimator that accounts for patients having multiple dilations and study clustered data. Factors that were seen in 5 or more patients and those that were reported for most dilations were considered for inclusion in the multivariable model and a stepwise variable selection method was used to choose the final model.

Surgery. Patient-level data were used to assess factors associated with need for surgery. There were 4 patients who had no information regarding surgery and were excluded from this part of the analysis. Follow-up time was defined as months from the first dilation to time of surgery; patients were censored at the time of last follow-up visit if they did not have surgery. Unadjusted and multivariable Cox marginal model regression analysis was performed to assess factors associated with surgery; standard errors and *P* values were based on a robust (sandwich) variance estimator that accounted for patient clustering by study. Factors that were seen in 5 or more patients and those that were reported for most dilations were considered for inclusion in the multivariable model and a stepwise variable selection method was used to choose the final model. A *P* value less than .05 was considered statistically significant. All analyses were performed using SAS (version 9.4; The SAS Institute, Cary, NC) or R (meta-package, version 3.3.2; The R Institute for Statistical Computing, Vienna, Austria).

Literature Search and Data

We performed a formal systematic review with a comprehensive literature search to identify all relevant citations in Embase, Medline (service of the US National Library of Medicine and the National Institutes of Health), and the Cochrane library for the following key words: ('Crohn's disease (CD)' OR 'Crohn's' AND ('stricture' OR 'endoscopic dilatation' OR 'endoscopic dilation' OR 'balloon dilation' OR 'balloon dilatation')). A recursive search of bibliographies of relevant articles also was performed. The search included cohort studies since inception until December 2016 and only included full-text articles in English language. Eligible studies enrolled adult patients (age, >18 y) with a confirmed diagnosis of CD, strictures of the stomach or duodenum (up to the ligament of Treitz) associated with CD that were dilated using through-the-scope endoscopic balloon dilation. Exclusion criteria were an unclear diagnosis or use of dilation methods other than through-the-scope balloons. We decided to exclude patients with esophageal CD because the exact etiology of esophageal strictures in these patients often cannot be elucidated. This is particularly true for the distinction between reflux-related strictures and CD-associated strictures.

Two reviewers (D.B., M.M.M.) independently screened citations and abstracts. The full-text publications of potentially eligible studies were reviewed in duplicate by 2 pairs of researchers (D.B., M.M.M.). Disagreements regarding inclusion or extraction were resolved through discussion, or arbitration was performed by another author (F.R.).

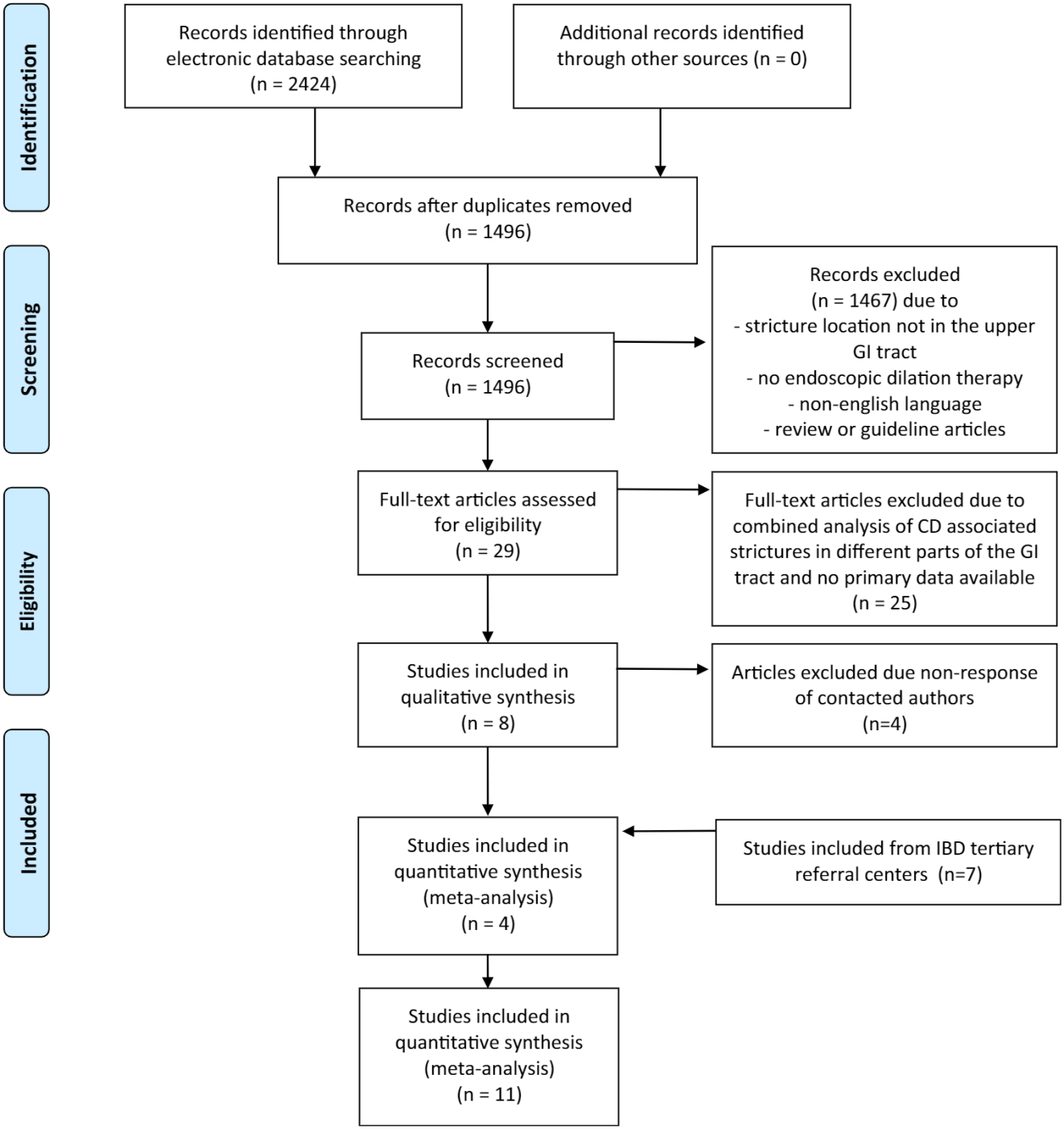
In addition, 7 high-volume inflammatory bowel disease endoscopy centers were contacted and asked to contribute adult patients (age, >18 y) with a confirmed diagnosis of CD, strictures of the stomach or duodenum (up to the ligament of Treitz) associated with CD that were dilated using through-the-scope endoscopic balloon dilation. Clinical data from 24 cumulative patients were transferred into an anonymized secured database. Data checks were performed. If discrepancies were detected they were resolved with the respective investigators. Ethical approval for this data collection was obtained by each local center and data were provided in a de-identified fashion. Nonresponding corresponding investigators were re-contacted up to 2 times. Four of 8 contacted investigators provided their complete data sets of 70 cumulative CD patients, whereas 4 investigators did not respond to our query. Ethical

approval of this pooled analysis was not needed because only published data were provided in a de-identified fashion. Missing individual-level data were handled as described in the Statistical Analysis section.

Data Collection

Technical success was defined mainly as the ability to dilate the stricture after starting the procedure. The definitions for technical success as mentioned in the individual publications can be found in Supplementary Table 1. The definition for short-term clinical efficacy were improvement or relief of symptoms of obstruction. The definitions for clinical efficacy as mentioned in the individual publications can be found in Supplementary Table 1. Long-term success was defined as the absence of recurrent symptoms, redilation-free interval, and intervention-free period with no need for surgery after the first dilation. Major complications were defined as perforation, bleeding, or dilation-related surgery. The need for surgery was defined as surgery at the site of the dilated stricture only. This did not include patients who had surgery in other areas of their intestine. For the additionally collected unpublished patients the following definitions were used. Technical success was defined as the ability to dilate the stricture after starting the procedure. The definition for short-term clinical efficacy included improvement or relief of symptoms of obstruction. Long-term success was defined as the absence of recurrent symptoms, redilation-free interval, and intervention-free period with no need for surgery after the first dilation. Major complications were defined as perforation, bleeding, or dilation-related surgery. The need for surgery was defined as surgery at the site of the dilated stricture only. Only symptomatic strictures with no concomitant fistula, abscess, dysplasia, or malignancy were included in the analysis.

For the individual per-patient analysis, a protocol was developed and items regarding demographics, disease phenotype, medications, and dilation procedures were collected for all included subjects. A detailed list depicting all assessed variables is shown in Tables 2 and 3. Because we did not have access to the individual patient charts we used the descriptors provided by the investigators and no patient was reclassified.



Supplementary Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram.

Supplementary Table 1. Definitions for Technical Success and Short-Term Clinical Efficacy in the Individual Studies

Definition for technical success	References
Ability to pass the scope beyond stricture after dilation	12
Passage of the endoscope through the stricture without resistance immediately after the dilation was performed safely	15
No definition provided	14
Dilatation of initially nontraversable strictures to a balloon diameter of 15 mm had been reached	13
Definition for short term clinical efficacy	
Relief of obstructive symptoms	12
Return to normal diet	15
Symptomatic relief (without postprandial fullness)	14
Remission of obstructive symptoms	13

Supplementary Table 2. Analysis of Factors Associated With Short-Term Clinical Efficacy: Generalized Linear Mixed Models: All Studies

	Unadjusted analysis		Adjusted analysis	
Factor	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Female vs male	1.8 (0.46–7.3)	.38	—	—
Asian vs Caucasian	0.52 (0.03–8.8)	.64	—	—
BMI, 1-kg/m^2 increment	1.2 (0.94–1.4)	.16	—	—
Family history of CD	0.56 (0.03–9.6)	.68	—	—
Smoking, past or present	5.2 (0.48–56.5)	.17	—	—
Age at diagnosis, 5-year increment	0.86 (0.64–1.2)	.33	—	—
Age at time of stricture diagnosis, 5-year increment	1.03 (0.80–1.3)	.82	—	—
Age at time of dilation, 5-year increment	1.1 (0.84–1.5)	.40	—	—
Disease in jejunum/proximal ileum	1.08 (0.23–5.0)	.92	—	—
Disease in ileocecum	0.27 (0.06–1.2)	.083	0.27 (0.058–1.2)	.087
Disease in colon	2.1 (0.48–9.5)	.31	—	—
Disease in rectum	4.5 (0.81–24.6)	.083	—	—
EIM	0.70 (0.12–4.2)	.69	—	—
Stomach stricture	1.08 (0.24–4.9)	.92	—	—
Duodenum stricture	1.05 (0.23–4.9)	.95	—	—
De novo vs postsurgical/anastomotic stricture	1.4 (0.03–72.1)	.82	—	—
Length, $\leq$5 vs $>$5 cm	0.31 (0.015–6.2)	.44	—	—
Prestenotic dilation	0.30 (0.08–1.2)	.084	0.31 (0.079–1.3)	.099
PPI at the time of dilation	1.03 (0.22–4.9)	.97	—	—
Anti-TNF at time of dilation	3.6 (0.35–36.5)	.28	—	—
Graded dilation	1.9 (0.38–9.7)	.43	—	—
Abnormal mucosa at time of dilation	0.77 (0.19–3.1)	.71	—	—
Maximum caliber of dilation, 1-mm increment	1.2 (0.97–1.6)	.092	—	—
Steroid injection	0.40 (0.03–6.2)	.50	—	—

BMI, body mass index; EIM, extraintestinal manifestation; PPI, proton pump inhibitor.

Supplementary Table 3. Analysis of Factors Associated With Recurrence of Symptoms After Clinical Efficacy: Cox Marginal Models: All Studies

Factor	Unadjusted analysis		Multivariable analysis	
	HR (95% CI)	*P* value	HR (95% CI)	*P* value
Female vs male	1.2 (0.70–2.1)	.50	—	—
Asian vs Caucasian	1.1 (0.65–2.0)	.68	—	—
BMI, 1-kg/m^2 increment	0.97 (0.93–1.02)	.29	—	—
Family history of CD	0.99 (0.19–5.2)	.99	—	—
Smoking, past or present	1.08 (0.62–1.9)	.80	—	—
Age at diagnosis, 5-year increment	0.89 (0.75–1.04)	.15	0.85 (0.72–1.00)	.054
Age at time of stricture diagnosis, 5-year increment	1.02 (0.93–1.1)	.65	—	—
Age at time of dilation, 5-year increment	1.02 (0.93–1.1)	.61	—	—
Disease in jejunum/proximal ileum	1.8 (1.09–2.9)	***.022***	2.1 (1.3–3.5)	***.003***
Disease in ileocecum	1.4 (0.83–2.4)	.20	1.6 (0.96–2.6)	.073
Disease in colon	1.05 (0.63–1.7)	.85	—	—
Disease in rectum	1.2 (0.70–2.0)	.50	—	—
EIM	1.6 (0.88–2.8)	.12	—	—
Stomach stricture	1.6 (0.85–2.9)	.15	—	—
Duodenum stricture	0.74 (0.38–1.4)	.37	—	—
De novo vs postsurgical/anastomotic stricture	0.79 (0.29–2.1)	.64	—	—
Length, ≤5 vs >5 cm	0.41 (0.24–0.70)	***.001***	—	—
Prestenotic dilation	1.2 (0.68–2.0)	.59	—	—
PPI at the time of dilation	1.08 (0.58–2.0)	.81	—	—
Anti-TNF at time of dilation	1.2 (0.68–2.0)	.56	—	—
Graded dilation	1.01 (0.55–1.8)	.98	—	—
Abnormal mucosa at time of dilation	1.1 (0.65–2.0)	.65	—	—
Maximum caliber of dilation, 1-mm increment	0.96 (0.86–1.06)	.41	—	—
Steroid injection	0.62 (0.06–6.7)	.69	—	—

NOTE. Bolded and italicized values indicate *P* values < .05.
BMI, body mass index; EIM, extraintestinal manifestation; PPI, proton pump inhibitor.

Supplementary Table 4. Analysis of Factors Associated With Stricture Redilation: Cox Marginal Models: All Models

Factor	Unadjusted analysis		Multivariable analysis	
	HR (95% CI)	*P* value	HR (95% CI)	*P* value
Female vs male	1.3 (0.82–2.0)	.28	—	—
Asian vs Caucasian	2.8 (1.7–4.5)	***<.001***	2.8 (1.8–4.5)	***<.001***
BMI, 1-kg/m^2 increment	0.97 (0.92–1.02)	.24	—	—
Family history of CD	0.37 (0.09–1.5)	.17	—	—
Smoking, past or present	0.91 (0.54–1.5)	.73	—	—
Age at diagnosis, 5-year increment	0.97 (0.87–1.09)	.63	—	—
Age at time of stricture diagnosis, 5-year increment	0.92 (0.81–1.04)	.16	—	—
Age at time of dilation, 5-year increment	0.92 (0.82–1.04)	.18	—	—
Disease in jejunum/proximal ileum	1.7 (1.1–2.6)	***.015***	1.9 (1.2–2.9)	***.004***
Disease in ileocecum	0.85 (0.55–1.3)	.48	—	—
Disease in colon	1.1 (0.74–1.7)	.56	—	—
Disease in rectum	0.85 (0.55–1.3)	.46	—	—
EIM	0.74 (0.44–1.2)	.25	—	—
Stomach stricture	1.2 (0.77–2.0)	.40	—	—
Duodenum stricture	0.91 (0.55–1.5)	.73	—	—
De novo vs postsurgical/anastomotic stricture	1.00 (0.58–1.7)	.99	—	—
Length, ≤5 vs >5 cm	0.49 (0.22–1.07)	.075	—	—
Prestenotic dilation	1.4 (0.90–2.2)	.13	—	—
PPI at the time of dilation	1.5 (0.86–2.6)	.16	—	—
Anti-TNF at time of dilation	0.81 (0.49–1.3)	.42	—	—
Graded dilation	0.80 (0.52–1.2)	.31	—	—
Abnormal mucosa at time of dilation	1.6 (1.00–2.6)	.051	—	—
Maximum caliber of dilation, 1-mm increment	1.03 (0.95–1.1)	.44	—	—
Steroid injection	0.35 (0.09–1.4)	.13	—	—

NOTE. Bolded and italicized values indicate *P* values < .05.
BMI, body mass index; EIM, extraintestinal manifestation; PPI, proton pump inhibitor.

Supplementary Table 5. Analysis of Factors Associated With Stricture Surgery: Cox Marginal Models: All Studies

Factor	Unadjusted analysis		Multivariable analysis	
	HR (95% CI)	*P* value	HR (95% CI)	*P* value
Female vs male	0.81 (0.31–2.1)	.67	—	—
Asian vs Caucasian	1.7 (1.2–2.3)	***.003***	0.96 (0.90–1.02)	.15
BMI, 1-kg/m^2 increment	0.91 (0.87–0.96)	***<.001***	—	—
Family history of CD	0.71 (0.51–0.99)	***.046***	—	—
Smoking, past or present	0.89 (0.39–2.1)	.79	—	—
Age at diagnosis, 5-year increment	1.03 (0.89–1.2)	.68	—	—
Age at time of stricture diagnosis, 5-year increment	0.95 (0.88–1.02)	.18	—	—
Age at time of dilation, 5-year increment	0.92 (0.87–0.98)	***.007***	—	—
Disease in jejunum/proximal ileum	1.4 (0.72–2.7)	.32	—	—
Disease in ileocecum	1.6 (0.90–2.9)	.11	—	—
Disease in colon	0.99 (0.63–1.5)	.96	—	—
Disease in rectum	0.73 (0.29–1.8)	.51	—	—
EIM	0.85 (0.51–1.4)	.55	—	—
Stomach stricture	1.2 (0.60–2.4)	.61	—	—
Duodenum stricture	0.78 (0.39–1.6)	.49	—	—
De novo vs postsurgical/anastomotic stricture	1.00 (0.55–1.8)	.99	—	—
Length, ≤5 vs >5 cm	0.79 (0.46–1.3)	.38	—	—
Prestenotic dilation	2.0 (1.4–2.7)	***<.001***	1.9 (1.3–2.7)	***.001***
PPI at the time of dilation	0.94 (0.48–1.9)	.86	—	—
Anti-TNF at time of dilation	1.6 (0.72–3.7)	.24	—	—
Graded dilation	0.88 (0.50–1.5)	.65	—	—
Abnormal mucosa at time of dilation	1.8 (0.67–4.8)	.25	—	—
Maximum caliber of dilation, 1-mm increment	0.90 (0.79–1.03)	.12	—	—
Steroid injection	1.8 (0.12–25.7)	.68	—	—

NOTE. Bolded and italicized values indicate *P* values < .05.
BMI, body mass index; EIM, extraintestinal manifestation; PPI, proton pump inhibitor.

Supplementary Table 6. Analysis of Factors Associated With Short-Term Clinical Efficacy: Generalized Linear Mixed Models: Published Studies*

Factor	Unadjusted analysis		Adjusted analysis	
	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Female vs male	2.6 (0.52–12.5)	.24	—	—
Asian vs Caucasian	0.73 (0.01–52.6)	.88	—	—
BMI, 1-kg/m^2 increment	1.1 (0.93–1.4)	.19	—	—
Family history of CD	0.62 (0.04–10.8)	.74	—	—
Smoking, past or present	5.5 (0.49–62.3)	.16	—	—
Age at diagnosis, 5-year increment	0.98 (0.68–1.4)	.90	—	—
Age at time of stricture diagnosis, 5-year increment	1.1 (0.83–1.5)	.45	—	—
Age at time of dilation, 5-year increment	1.2 (0.85–1.6)	.35	—	—
Disease in jejunum/proximal ileum	1.8 (0.28–11.7)	.52	—	—
Disease in ileocecum	0.35 (0.07–1.8)	.20	0.32 (0.059–1.8)	.20
Disease in colon	2.1 (0.43–10.6)	.35	—	—
Disease in rectum	5.2 (0.86–31.0)	.071	—	—
EIM	0.94 (0.15–5.7)	.94	—	—
Stomach stricture	1.00 (0.20–5.1)	.99	—	—
Duodenum stricture	1.2 (0.23–6.5)	.80	—	—
De novo vs postsurgical/anastomotic stricture	1.5 (0.012–150.2)	.87	—	—
Length, ≤5 vs >5 cm	0.25 (0.012–5.1)	.37	—	—
Prestenotic dilation	0.25 (0.05–1.2)	.087	0.25 (0.050–1.2)	.084
PPI at the time of dilation	1.3 (0.25–6.6)	.76	—	—
Anti-TNF at time of dilation	2.7 (0.23–31.3)	.41	—	—
Graded dilation	1.3 (0.16–10.5)	.81	—	—
Abnormal mucosa at time of dilation	1.01 (0.22–4.6)	.98	—	—
Maximum caliber of dilation, 1-mm increment	1.3 (1.00–1.8)	.050	—	—
Steroid injection	0.24 (0.01–5.5)	.36	—	—

BMI, body mass index; EIM, extraintestinal manifestation; PPI, proton pump inhibitor.

Supplementary Table 7. Analysis of Factors Associated With Recurrence of Symptoms After Clinical Efficacy: Cox Marginal Models Factor: Published Studies*

	Unadjusted analysis		Multivariable analysis	
	HR (95% CI)	*P* value	HR (95% CI)	*P* value
Female vs male	1.09 (0.60–2.0)	.78	—	—
Asian vs Caucasian	0.83 (0.47–1.5)	.53	—	—
BMI, 1-kg/m^2 increment	0.97 (0.91–1.03)	.27	—	—
Family history of CD	0.90 (0.16–5.0)	.90	—	—
Smoking, past or present	1.05 (0.57–1.9)	.89	—	—
Age at diagnosis, 5-year increment	0.92 (0.80–1.07)	.27	0.90 (0.77–1.04)	.16
Age at time of stricture diagnosis, 5-year increment	1.01 (0.91–1.1)	.86	—	—
Age at time of dilation, 5-year increment	1.01 (0.91–1.1)	.91	—	—
Disease in jejunum/proximal ileum	1.5 (0.92–2.6)	.10	1.7 (1.02–2.9)	***.042***
Disease in ileocecal	1.2 (0.65–2.1)	.60	—	—
Disease in colon	0.73 (0.41–1.3)	.28	—	—
Disease in rectum	0.89 (0.50–1.6)	.71	—	—
EIM	1.2 (0.67–2.2)	.50	—	—
Stomach stricture	1.2 (0.62–2.5)	.53	—	—
Duodenum stricture	0.97 (0.45–2.1)	.93	—	—
De novo vs postsurgical/anastomotic stricture	0.23 (0.09–0.58)	***.002***	—	—
Length, ≤5 vs >5 cm	0.48 (0.26–0.87)	***.015***	—	—
Prestenotic dilation	0.64 (0.34–1.2)	.18	0.65 (0.33–1.3)	.22
PPI at the time of dilation	0.71 (0.30–1.6)	.42	—	—
Anti-TNF at time of dilation	0.95 (0.48–1.9)	.88	—	—
Graded dilation	1.5 (0.74–3.1)	.25	—	—
Abnormal mucosa at time of dilation	1.2 (0.67–2.2)	.52	—	—
Maximum caliber of dilation, 1-mm increment	0.94 (0.83–1.07)	.33	—	—

NOTE. Bolded and italicized values indicate *P* values < .05.
BMI, body mass index; EIM, extraintestinal manifestation; PPI, proton pump inhibitor.

Supplementary Table 8. Analysis of Factors Associated With Stricture Redilation: Cox Marginal Models: Published Studies*

	Unadjusted analysis		Multivariable analysis	
Factor	HR (95% CI)	*P* value	HR (95% CI)	*P* value
Female vs male	1.2 (0.75–2.0)	.44	—	—
Asian vs Caucasian	2.7 (1.7–4.3)	***<.001***	3.6 (2.2–6.1)	***<.001***
BMI, 1-kg/m^2 increment	0.95 (0.90–1.01)	.13	—	—
Family history of CD	0.37 (0.09–1.5)	.17	—	—
Smoking, past or present	1.10 (0.65–1.8)	.73	—	—
Age at diagnosis, 5-year increment	1.00 (0.90–1.1)	.99	—	—
Age at time of stricture diagnosis, 5-year increment	0.94 (0.83–1.06)	.29	—	—
Age at time of dilation, 5-year increment	0.93 (0.82–1.05)	.26	—	—
Disease in jejunum/proximal ileum	1.5 (0.98–2.4)	.060	1.5 (0.99–2.3)	.056
Disease in ileocecum	0.81 (0.51–1.3)	.37	—	—
Disease in colon	0.96 (0.61–1.5)	.86	—	—
Disease in rectum	0.74 (0.46–1.2)	.20	—	—
EIM	0.62 (0.37–1.05)	.075	—	—
Stomach stricture	1.2 (0.75–2.0)	.43	—	—
Duodenum stricture	0.93 (0.54–1.6)	.78	—	—
De novo vs postsurgical/anastomotic stricture	1.2 (0.81–1.8)	.35	—	—
Length, ≤5 vs >5 cm	0.50 (0.23–1.08)	.078	—	—
Prestenotic dilation	1.08 (0.70–1.7)	.74	—	—
PPI at the time of dilation	1.2 (0.58–2.5)	.62	—	—
Anti-TNF at time of dilation	0.51 (0.31–0.82)	***.006***	—	—
Graded dilation	0.82 (0.51–1.3)	.39	1.9 (1.2–3.0)	***.011***
Abnormal mucosa at time of dilation	1.9 (1.04–3.3)	***.037***	2.1 (1.09–3.9)	***.025***
Maximum caliber of dilation, 1-mm increment	1.05 (0.97–1.1)	.24	—	—
Steroid injection	0.22 (0.05–0.94)	***.041***	—	—

NOTE. Bolded and italicized values indicate *P* values < .05.
BMI, body mass index; EIM, extraintestinal manifestation; PPI, proton pump inhibitor.

Supplementary Table 9. Analysis of Factors Associated With Stricture Surgery: Cox Marginal Models: Published Studies*

Factor	Unadjusted analysis		Multivariable analysis	
	HR (95% CI)	*P* value	HR (95% CI)	*P* value
Female vs male	0.54 (0.24–1.2)	.15	—	—
Asian vs Caucasian	1.8 (1.4–2.3)	***<.001***	3.0 (2.3–3.9)	***<.001***
BMI, 1-kg/m^2 increment	0.90 (0.88–0.92)	***<.001***	—	—
Family history of CD	0.69 (0.49–0.96)	***.029***	—	—
Smoking, past or present	0.74 (0.29–1.8)	.51	—	—
Age at diagnosis, 5-year increment	0.94 (0.85–1.05)	.28	—	—
Age at time of stricture diagnosis, 5-year increment	0.94 (0.90–0.97)	***<.001***	—	—
Age at time of dilation, 5-year increment	0.93 (0.89–0.96)	***<.001***	—	—
Disease in jejunum/proximal ileum	0.90 (0.43–1.9)	.77	—	—
Disease in ileocecum	1.9 (1.7–2.1)	***<.001***	—	—
Disease in colon	0.90 (0.67–1.2)	.48	—	—
Disease in rectum	0.73 (0.25–2.1)	.56	—	—
EIM	0.63 (0.35–1.1)	.11	—	—
Stomach stricture	1.4 (0.65–2.8)	.42	—	—
Duodenum stricture	0.67 (0.33–1.4)	.28	—	—
De novo vs postsurgical/anastomotic stricture	0.44 (0.02–10.8)	.62	—	—
Length, ≤5 vs >5 cm	0.73 (0.43–1.2)	.24	—	—
Prestenotic dilation	1.8 (1.08–2.9)	***.023***	—	—
PPI at the time of dilation	0.74 (0.31–1.8)	.50	—	—
Anti-TNF at time of dilation	2.0 (1.3–3.2)	***.003***	3.5 (2.6–4.8)	***<.001***
Graded dilation	0.87 (0.44–1.7)	.68	—	—
Abnormal mucosa at time of dilation	1.6 (0.63–3.8)	.33	—	—
Maximum caliber of dilation, 1-mm increment	0.89 (0.76–1.04)	.14	—	—
Steroid injection	21.5 (10.3–44.8)	***<.001***	47.5 (24.8–91.1)	***<.001***

NOTE. Bolded and italicized values indicate *P* values < .05.
BMI, body mass index; EIM, extraintestinal manifestation; PPI, proton pump inhibitor.

Supplementary Table 10. Outcomes by Dilation Number

Factor	First dilation (N = 103)		Second dilation (N = 22)		Third dilation (N = 9)		*P* value
	n	Summary	n	Summary	n	Summary	
Technical success	102	102 (100.0)	22	22 (100.0)	9	9 (100.0)	—
Clinical success	87	75 (86.2)	20	17 (85.0)	9	8 (88.9)	.96
Redilation	99	61 (61.6)	22	12 (54.5)	9	6 (66.7)	.77
Months to redilation	61	2.0 [1.2, 6.0]	12	1.6 [1.02, 7.0]	6	9.1 [5.8, 16.8]	.23