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New-Onset Erosive Esophagitis after Laparoscopic Sleeve Gastrectomy: Does Preoperative Esophagogastric Junction Anatomy Matter?

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Abbreviations:
ASA: American Society of Anesthesiologists;
BMI: body mass index;
CCI: Comprehensive Complication Index;
CD: Clavien–Dindo;
CI: confidence interval;
EGD: esophagogastroduodenoscopy;
EGJ: esophagogastric junction;
GERD: gastroesophageal reflux disease;
IQR: interquartile range;
LA: Los Angeles;
LSG: laparoscopic sleeve gastrectomy;
OR: odds ratio;
SD: standard deviation;
STROBE: Strengthening the Reporting of Observational Studies in Epidemiology.

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Rezumat

Esofagita erozivă nou-instalată după gastrectomia longitudinală laparoscopică: contează anatomia preoperatorie a joncțiunii esogastrice?

Introducere: Gastrectomia longitudinală laparoscopică (LSG) supune joncțiunea esogastrică unei provocări refluxogene, iar competența acesteia diferă înainte de operație.
Material şi metodă: Date clinice colectate de rutină pentru 250 de proceduri LSG index dintr-un centru bariatric privat (2020-2025), analizate retrospectiv. Analiza de asociere a necesitat mucoasă bazală normală şi endoscopie validă la 274-456 zile. Hernia hiatală şi gradul Hill, modelate separat şi împreună, cu analize de sensibilitate. 67 de pacienți sunt raportați şi separat.
Rezultate: Morbiditate majoră 7/250 (2,8%), fistulă 2/250 (0,8%), mortalitate 0/250. Dintre cei 239 cu mucoasă bazală normală, 228 au atins ținta, iar 139 aveau endoscopie în fereastră; 48 cu esofagită erozivă nou-instalată (34,5%; 33 LA-A, 15 LA-B), 15/139 LA-B–D (10,8%). Hernia hiatală (20/33 vs. 28/106; OR ajustat 4,34, 1,85–10,14) şi gradul Hill (OR ajustat 2,13/grad, 1,36–3,35) s-au asociat separat, cu creştere de la 6/35 (17,1%) la Hill I la 5/7 (71,4%) la Hill IV. În perioada cu captare cvasi-completă, esofagită la 19/61. Patru măsuri tehnice: fără asociere detectată.
Concluzii: Hernia hiatală şi gradul Hill preoperator s-au asociat cu esofagita erozivă nou-instalată după LSG, inclusiv în perioada cu captare cvasi-completă. Rezultatele susțin evaluarea anatomică deliberată, dar nu demonstrează echivalența tehnică şi nu identifică o strategie antireflux optimă.

Cuvinte cheie: gastrectomie longitudinală laparoscopică, esofagită endoscopică, clasificarea Los Angeles, hernie hiatală, grad Hill, siguranță perioperatorie

Abstract

Background: Laparoscopic sleeve gastrectomy (LSG) imposes a reflux challenge on an

esophagogastric junction whose competence varies before surgery.
Methods: Routinely collected data from 250 consecutive index LSG procedures at a private bariatric center (2020–2025) were analyzed retrospectively. Association analyses required normal baseline mucosa and a valid endoscopy 274–456 days after surgery. Hiatal hernia and Hill grade were modeled separately and jointly, with sensitivity analyses. A 67-patient subset is reported separately.
Results: Of 239 baseline-normal patients, 228 were target-due; 139 had window endoscopy; 48 had new-onset erosive esophagitis (34.5%; 33 LA-A, 15 LA-B), 15/139 LA-B–D (10.8%). Hiatal hernia (20/33 versus 28/106; adjusted OR 4.34, 95% CI 1.85–10.14) and Hill grade (adjusted OR 2.13/grade, 1.36–3.35) were associated separately, rising from 6/35 (17.1%) at Hill I to 5/7 (71.4%) at Hill IV. In the near-complete-capture period (61/62 examined), esophagitis occurred in 19/61 (hernia OR 8.25). No association was detected for four technical measures. Major morbidity 7/250 (2.8%), leak 2/250 (0.8%), mortality 0/250.
Conclusions: Preoperative hiatal hernia and increasing Hill grade were associated with new-onset erosive esophagitis after LSG, including in the near-complete-capture period. These findings support deliberate anatomical assessment but do not establish technical equivalence or identify an optimal antireflux strategy.

Keywords: laparoscopic sleeve gastrectomy, endoscopic esophagitis, Los Angeles classification, hiatal hernia, Hill grade, perioperative safety

Introduction

Laparoscopic sleeve gastrectomy is widely used in metabolic and bariatric surgery, but postoperative reflux and erosive esophageal injury remain clinically important concerns. Randomized, prospective, and pooled evidence documents substantial reflux-related morbidity after LSG, with estimates varying by endpoint definition and follow-up method (1-5). Symptoms, medication use, endoscopic injury, and abnormal reflux monitoring are related but non-interchangeable constructs; labeling any one of them as de novo GERD can obscure what was actually measured.

Endoscopy offers a reproducible description of mucosal injury using the LA classification (6,7). Contemporary diagnostic criteria consider LA grade B or higher conclusive endoscopic evidence of GERD, whereas LA-A alone is supportive but not conclusive (6). A study centered on incident endoscopic esophagitis should therefore report the full LA-grade outcome while separately testing LA-B-or-higher, rather than treating all mucosal breaks as equivalent proof of GERD.

The determinants of post-LSG esophageal injury may include both altered sleeve geometry and pre-existing competence of the EGJ. Physiologic and pooled studies demonstrate increased acid exposure and objective reflux burden after LSG (5,8,9), while observational and consensus data implicate bougie size, resection geometry, and other construction choices (10-12). The Hill flap-valve grade has an established anatomical basis and has been associated with postoperative reflux or erosive esophagitis (13-16). Silent preoperative reflux can further complicate de novo labeling (17). Separating these contributions is difficult in multi-operator cohorts and when the endpoint is not endoscopically anchored.

We therefore analyzed a single-team cohort with two distinct aims: to describe 30-day perioperative safety in all consecutive index LSG procedures, and to estimate incident endoscopic esophagitis at a fixed postoperative interval among patients with normal baseline mucosa. Within the latter cohort, we examined hiatal hernia and Hill grade as overlapping representations of baseline junctional anatomy and assessed four unambiguous operative measures in an explicitly exploratory technical panel.

Material and Methods

Study Design, Reporting, and Data Lock

This cohort study used routinely collected clinical data from consecutive laparoscopic sleeve gastrectomy procedures performed by a single surgical team at a private bariatric center in Constanta, Romania, between 2020 and 2025. The present research question and analysis plan were specified retrospectively. Preoperative endoscopy reports and baseline questionnaire variables were available for all 250 patients. A structured collection pathway, with questionnaires administered at fixed postoperative timepoints and follow-up endoscopy scheduled accordingly, was introduced in February 2023; for procedures performed earlier, postoperative follow-up was opportunis-

tic and some baseline and follow-up symptom fields were reconstructed retrospectively from mixed sources, including patient recall. Endpoint capture therefore differs between the two periods, and the analysis was anchored on dated source documents — endoscopy and operative reports — with symptom-based measures reported only as secondary or sensitivity analyses. The report follows STROBE recommendations (18). The database was locked on 28 May 2026; the most recent recorded endoscopy, on 23 May 2026, was used as the administrative censoring date. All analyses were recalculated from the granular source sheets, not from derived duplicate fields. Before the analysis was frozen, every record with an internal conflict between the dedicated endoscopy register and the general registry, and every record coded as prior bariatric history, was adjudicated against the original source document (endoscopy report or admission chart) by the operating surgeon while blinded to the postoperative endoscopic outcome; where sources conflicted, the original source document took precedence over any derived register. The registry records no separate operative date, so the date of index admission was used as the index date throughout; all primary-window examinations fell at 340 to 410 days from that date.

Cohorts and Eligibility

The registry contained 263 operative episodes. Thirteen were excluded: five re-sleeves, four N-Sleeve procedures combining sleeve and fundoplication, two Roux-en-Y gastric bypasses, and two one-anastomosis gastric bypasses. This left 250 consecutive index LSG procedures for perioperative safety analyses. Six patients were coded as having a prior bariatric history. Source-document review of their admission records showed that none had undergone any previous bariatric procedure: the documented operations were appendectomy, caesarean section, cardiac stenting, coronary angioplasty and surgery for chronic venous insufficiency, so this registry field had captured general rather than bariatric surgical history. All six were retained, so the source cohort for the association pathway comprised all 250 index procedures.

Preoperative endoscopy identified normal esophageal mucosa in 239/250 patients. Of the remaining 11, five had LA-A, three had LA-B, and three could not be classified; all 11 were excluded from the incident-esophagitis risk set. A patient reached the 12-month target once at least 365 days had elapsed between surgery and the censoring date; entering the 274-day lower edge of the window did not count, because that patient's window had not yet closed. On that definition, 228 of the 239 baseline-normal patients had reached the 12-month target and 11 were not yet due. The primary analysis included 139 target-due patients with a valid EGD 9–15 months after surgery. Eight of these 139 had passed 365 but not 456 days at censoring, so their window was still open, but all eight had already undergone the endpoint EGD. All 89 target-due patients without a window EGD had passed the full 456-day window (shortest surgery-to-censoring interval 656 days), so no missing outcome is administratively censored. *Fig. 1* shows every cohort transition and denominator. A subset of this cohort is also included in a separate report by the same team, which addresses a different question under a different endpoint definition; all 67 patients in that report belong to the present 250-patient operative cohort and were operated from February 2023 onward. Among the 139 patients in the primary analysis, 61 were shared and contributed 19 of the 48 incident-esophagitis events and 4 of the 15 LA-B–D events. For the isolated symptomatic transition, 34 of 72 patients were shared and contributed 7 of the 26 events. Among the 71 patients evaluable for the symptom-plus-endoscopy sensitivity analysis, 34 were shared and contributed 5 of the 17 events. The near-complete-capture sensitivity analysis comprises those same 61 shared patients and all 19 of its events, so it is an internal check on missingness rather than an independent replication. The two reports therefore do not constitute independent cohorts and must not be pooled as such.

Operative Practice

All procedures were laparoscopic and were performed by one surgical team; the lead surgeon performed 248/250 procedures. Bougie caliber ranged from 34 to 40 Fr (34 Fr, n=40; 36 Fr, n=109; 38 Fr, n=68; 40 Fr, n=33). Staple-line reinforcement was used in all procedures (continuous Maxon suture, n=245; buttress, n=5). Hiatal dissection and crural repair were performed selectively and were perfectly coincident in the registry: the same 75/250 patients underwent both. All 65 patients with a preoperative endoscopic hiatal hernia underwent repair, while 10 additional repairs occurred without a documented preoperative hernia. Consequently, no untreated-hernia comparator exists and the independent effect of repair cannot be estimated in this design; crural repair is therefore interpreted as a marker of risk anatomy rather than as a tested intervention.

The technical association panel was limited to four clearly defined registry variables: bougie caliber, the recorded intraoperative estimate of distance from the resection line to the angle of His, number of stapler

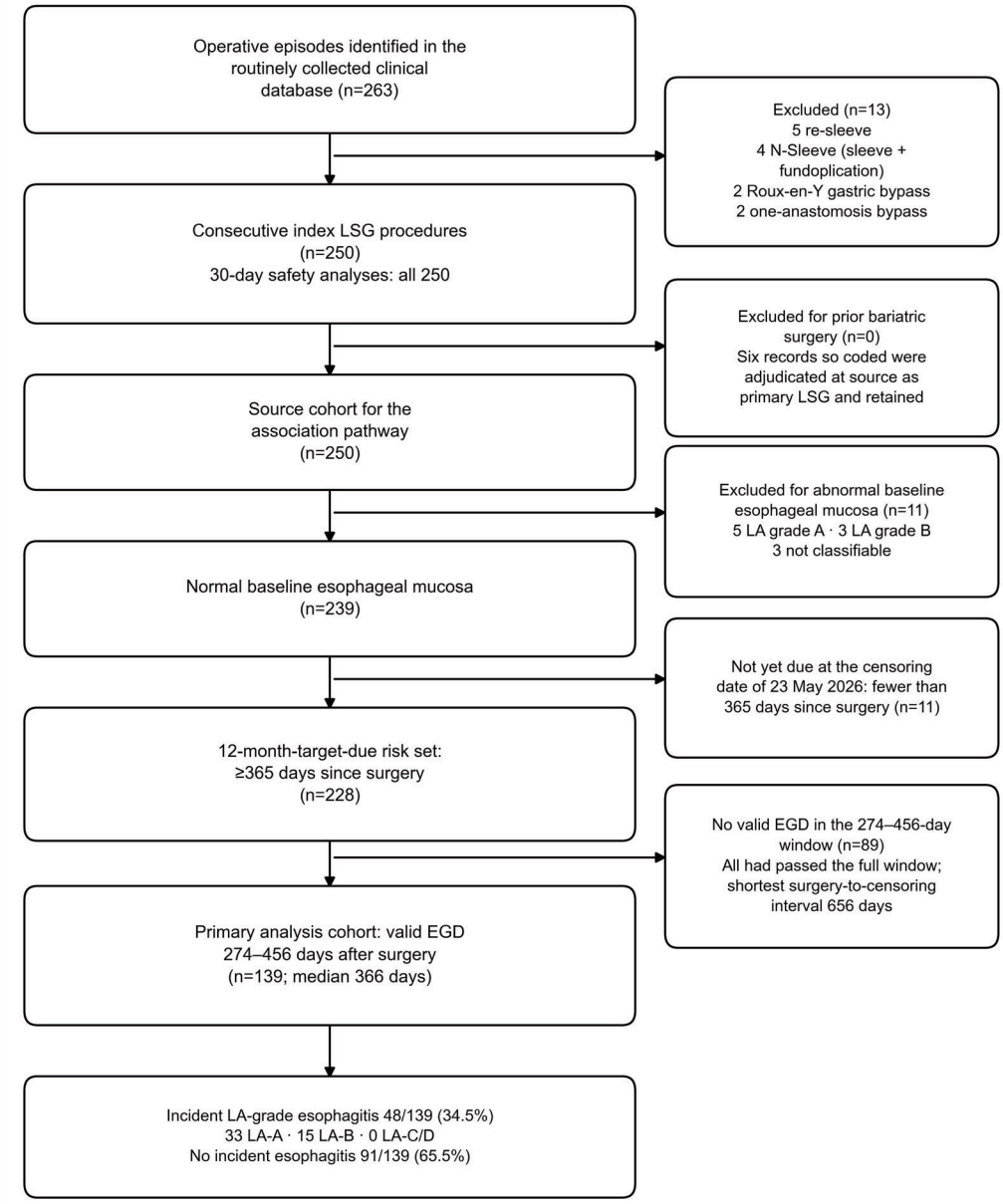


Figure 1. Cohort flow. The complete index-LSG cohort was used for 30-day safety. Association analyses excluded baseline mucosal abnormalities only; after source adjudication no patient was excluded for prior bariatric history. The primary endpoint required a valid EGD in the 9–15-month window among patients who had reached the 12-month target by the censoring date. LA, Los Angeles; LSG, laparoscopic sleeve gastrectomy.

cartridges, and operative time. These were analyzed as continuous variables and standardized to one within-cohort SD. Two registry fields intended to characterize the antral starting point, distance from the pylorus and antral preservation, were excluded from the inferential panel because their operational definitions and patient-level values could not be reconciled during source audit: across 246 paired records in the operative cohort the two fields were essentially uncorrelated ($r=-0.01$), so neither could be established as the valid measure of the antral landmark. This exclusion was based on measurement validity rather than on outcome associations, and the study accordingly provides no interpretable estimate for the position of the antral starting point.

Endoscopic Assessment and Outcomes

Upper gastrointestinal endoscopy recorded esophageal mucosal status using the LA classification, hiatal

hernia as present or absent, and Hill grade I-IV of the gastroesophageal flap valve (7,13). The dedicated endoscopy register was the canonical source and contained one preoperative EGD per included patient; conflicts were adjudicated as described above. A valid EGD required an actual examination date and an interpretable mucosal category (no esophagitis or LA grade A–D). The primary outcome was any incident LA-grade esophagitis (A–D) in a patient with normal baseline mucosa, assessed 274-456 days after the index admission. This window (approximately 9-15 months) was chosen to represent a one-year assessment while allowing realistic scheduling variation, and to avoid pooling early (approximately 6-month) with late (approximately 24-month) examinations, which would confound incidence with time since surgery. If more than one valid EGD fell within this window, the examination closest to 365.25 days was selected; no patient had multiple valid examinations in the primary window.

LA-B or higher was analyzed as a clinically stricter endpoint because Lyon Consensus 2.0 treats LA-B–D, but not isolated LA-A, as conclusive endoscopic evidence of GERD (6). A broader-timing sensitivity selected the valid postoperative EGD whose actual date was closest to 365.25 days, irrespective of registry timepoint label, and a second timing sensitivity used a fixed 183-548-day (approximately 6-18-month) window. Further sensitivities restricted eligibility to patients with at least 456 days before the censoring date and rederived a symptom-plus-endoscopy composite endpoint on the same risk set under identical eligibility and timing rules (preoperative GERD-Q below 8 progressing to GERD-Q of 8 or more together with incident endoscopic esophagitis), so that a composite and an endoscopy-only definition could be compared in the same patients. Patients operated before the February 2023 pathway had incomplete and non-systematic postoperative endoscopic follow-up, and the indication for each examination was not separately encoded. Calendar dependence was therefore addressed by restricting the analysis to procedures from February 2023 onward, with the earlier period reported alongside, rather than by entering five year indicators, which the event count would not support; restriction adds no parameters. The register did not encode whether examinations were scheduled surveillance or symptom-prompted, did not ensure capture of examinations performed elsewhere, and did not record endoscopist identity or blinding to clinical data.

Perioperative Outcomes

Thirty-day outcomes were secondary descriptive outcomes in the complete operative cohort, classified by Clavien–Dindo and summarized with the CCI (19,20). Safety outcomes were any 30-day complication, CD grade III or higher, staple-line leak, reoperation, readmission, intraoperative complication, conversion to open surgery, and 30-day mortality. Operative time, estimated blood loss, specimen weight, and length of stay were described on the complete operative cohort.

Statistical Analysis

Continuous data are reported as mean ± SD or median (IQR; range), and categorical data as n (%). Binary proportions use Wilson 95% CIs; the upper Wilson bound is reported when zero events occurred. Two-by-two comparisons used Fisher's exact test. Associations were estimated with ordinary maximum-likelihood logistic regression and Wald 95% CIs. No penalized regression was used.

Hiatal hernia and Hill grade were first modeled separately, unadjusted and adjusted for age, sex, and preoperative BMI. As a confounding check, both anatomical variables were additionally adjusted for the baseline GERD-HRQL score, a validated patient-reported measure available for all 139 patients; it was included solely as an adjustment covariate and was not analyzed as an outcome or focal exposure. Because these variables describe related aspects of the EGJ, exploratory shared models containing both were fitted without and with those demographic covariates to assess overlap rather than claim independent prediction. Technical variables were analyzed per one SD, individually and together with hiatal hernia. The technical panel was interpreted as signal detection, not as an equivalence or non-inferiority analysis.

No sample-size calculation was performed; all eligible records were included. Missing values were not imputed. Primary-window availability was summarized for incident, non-incident, and no-window-EGD groups without hypothesis testing. Extreme-case bounds treated all 89 missing primary outcomes first as non-events and then as events. Sensitivity and exploratory p values are nominal; no multiplicity adjustment was applied. Tests were two-sided with $p<0.05$. Analyses used Python 3 with pandas 2.3.3, SciPy 1.17.1, and statsmodels 0.14.6.

Ethics

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Ethics Committee of the Sf. Apostol Andrei Emergency County Clinical Hospital, Constanta (approval no. 31227, 11 May 2026). The committee

waived additional study-specific consent for this retrospective anonymized analysis. All patients had provided written consent for surgery and anonymized use of clinical data. The Ethics Committee of the participating private center, where the procedures were performed and the source records are held, reviewed and approved the clinical activity and the associated data collection at their inception and authorized their retrospective anonymized analysis; the written confirmation is available to the Editorial Office on request. Approval no. 31227 covers the retrospective anonymized analysis of routinely collected clinical data from the 2020-2025 surgical cohort and therefore postdates surgical accrual and precedes the database lock, whereas the participating center's approval of the clinical activity dates from its inception.

Results

Cohort and Endpoint Availability

The operative cohort comprised 250 index LSG procedures; 201/250 patients (80.4%) were women, median age was 44 years (range 18–74), median preoperative BMI was 40.9 kg/m², and 158/250 (63.2%) were ASA III–IV. All 250 entered the association pathway; the baseline-normal risk set, the 12-month-target-due risk set, and the primary-window cohort contained 239, 228, and 139 patients, respectively (*Fig. 1*). *Table 1* shows baseline features of the target-due risk set by observed primary outcome and missing primary-window endoscopy.

Primary-window EGD was available for 23/61 target-due patients operated in 2020, 33/62 in 2021, 22/43 in 2022, 25/25 in 2023, 26/27 in 2024, and 10/10 in 2025. Outcome availability was therefore strongly calendar-dependent: capture was 78/166 (47.0%) for procedures performed before February 2023 and 61/62 (98.4%) from that date onward. Missing endpoints are thus almost entirely a feature of the earlier period.

Perioperative Safety

Median operative time was 105 minutes (IQR 89-122; range 48-166), estimated blood loss 57 mL (IQR 32-81; range 10-131), specimen weight 117 g (IQR 92-135; range 50-194), and hospital stay 3 days (IQR 2-3.75; range 2-7). Any 30-day complication occurred in 28/250 (11.2%; 95% CI 7.9-15.7). Major morbidity was 7/250 (2.8%; 95% CI 1.4-5.7). Staple-line leak occurred in 2/250 (0.8%), reoperation in 5/250 (2.0%), readmission in 8/250 (3.2%), and intraoperative complication in 6/250 (2.4%). There were no conversions to open surgery (0/250) and no deaths (0/250). Median CCI was 0 (*Table 2*).

Incident Endoscopic Esophagitis

The 139 primary-window EGDs occurred at a median of 366 days (IQR 361-370; range 340-410). Incident esophagitis occurred in 48/139 (34.5%; 95% CI 27.1-42.8): 33 LA-A and 15 LA-B; no LA-C/D was recorded. The LA-B-or-higher rate was therefore 15/139 (10.8%; 95% CI 6.6-17.0). These are endoscopic outcomes and are not labeled de novo GERD because symptoms, antisecretory treatment at examination, and ambulatory reflux burden were not jointly adjudicated.

Table 1. Baseline characteristics of the 12-month-target-due, baseline-normal risk cohort by primary-window outcome availability.

Characteristic	Incident esophagitis (n=48)	No incident esophagitis (n=91)	No 9–15 month EGD (n=89)
Age, years	44.6 ± 12.8	42.8 ± 11.3	41.3 ± 10.5
Female sex	41 (85.4%)	76 (83.5%)	66 (74.2%)
Preoperative BMI, kg/m²	42.8 ± 6.4	40.9 ± 6.4	42.5 ± 7.3
ASA III–IV	33 (68.8%)	53 (58.2%)	60 (67.4%)
Preoperative hiatal hernia	20 (41.7%)	13 (14.3%)	23 (25.8%)
Hill grade I	6 (12.5%)	29 (31.9%)	20 (22.5%)
Hill grade II	14 (29.2%)	32 (35.2%)	28 (31.5%)
Hill grade III	23 (47.9%)	28 (30.8%)	35 (39.3%)
Hill grade IV	5 (10.4%)	2 (2.2%)	6 (6.7%)
Any 30-day complication	5 (10.4%)	12 (13.2%)	10 (11.2%)
Surgery from February 2023 onward	19 (39.6%)	42 (46.2%)	1 (1.1%)

Values are mean ± SD or n (%). No hypothesis tests were performed; the table exposes potential selection into primary-window EGD. Eleven additional baseline-normal patients had not reached the 12-month target by the censoring date and are not shown.

Table 2. Perioperative and 30-day outcomes in the complete operative cohort (N=250).

Outcome	Estimate	95% CI or distribution
Operative time, min	105 (89–122)	Range 48–166
Estimated blood loss, mL	57 (32–81)	Range 10–131
Specimen weight, g	117 (92–135)	Range 50–194
Length of stay, days	3 (2–3.75)	Range 2–7
Any 30-day complication	28/250 (11.2%)	7.9–15.7%
CD grade 0 / I / II / III / IV	222 / 14 / 7 / 5 / 2	Median CCI 0
Major morbidity, CD ≥III	7/250 (2.8%)	1.4–5.7%
Staple-line leak	2/250 (0.8%)	0.2–2.9%
Reoperation	5/250 (2.0%)	0.9–4.6%
Readmission	8/250 (3.2%)	1.6–6.2%
Intraoperative complication	6/250 (2.4%)	1.1–5.1%
Conversion to open surgery	0/250 (0%)	Upper bound 1.5%
30-day mortality	0/250 (0%)	Upper bound 1.5%

Continuous values are median (IQR). Binary outcome CIs are Wilson intervals; for zero events, the upper Wilson bound is shown. CD: Clavien–Dindo; CCI: Comprehensive Complication Index.

Observed incidence by year of surgery was 9/23 (39.1%) in 2020, 15/33 (45.5%) in 2021, 5/22 (22.7%) in 2022, 6/25 (24.0%) in 2023, 10/26 (38.5%) in 2024, and 3/10 (30.0%) in 2025. Of the 89 target-due patients without a primary-window EGD, 31 had undergone an interpretable postoperative endoscopy outside the 274-456-day window, 28 had a 12-month examination scheduled but not performed, and 30 had no 12-month entry in the test register. All 89 had passed the full 456-day window before censoring, so the missingness reflects incomplete surveillance rather than administrative censoring; only 1 of the 89 was operated from February 2023 onward. The extreme-case range was wide: 48/228 (21.1%) if all missing outcomes were non-events and 137/228 (60.1%) if all were events. The observed 48/139 (34.5%) should therefore be read as the incidence among patients actually examined.

Baseline Junctional Anatomy

Hiatal hernia was present in 33/139 patients with primary-window EGD. Incident esophagitis occurred in 20/33 (60.6%) with versus 28/106 (26.4%) without hiatal hernia (OR 4.29, 95% CI 1.89-9.74; Fisher p=0.0006). Adjustment for age, sex, and preoperative BMI produced a similar estimate (adjusted OR 4.34, 95% CI 1.85-10.14; p<0.001). Because all baseline hernias in the operative cohort underwent repair, this association describes a baseline risk phenotype and cannot estimate the effect of repair. Preoperative endoscopic documentation and intraoperative management were not perfectly aligned: all 65 patients with a preoperative endoscopic hernia underwent crural repair, and 62 of those 65 had been graded Hill III or IV, while a further 10 patients underwent crural repair without a preoperative endoscopic diagnosis of hiatal hernia, four of them with mesh-reinforced repair. In 8 of those 10, the same preoperative examination had already recorded a Hill grade of II or III.

Incident-esophagitis rates increased across Hill grades: 6/35 (17.1%) for grade I, 14/46 (30.4%) for II, 23/51 (45.1%) for III, and 5/7 (71.4%) for IV. The OR per one-grade increase was 2.08 (95% CI 1.34–3.23; p=0.001), and 2.13 (95% CI 1.36–3.35; p<0.001) after demographic adjustment. In the unadjusted shared model, hiatal-hernia and Hill estimates attenuated to OR 2.60 (95% CI 0.96-7.04; p=0.059) and OR 1.56 (95% CI 0.92–2.64; p=0.095). In the shared model adjusted for age, sex, and BMI, corresponding estimates were 2.45 (95% CI 0.85-7.06; p=0.098) and 1.62 (95% CI 0.93-2.80; p=0.086). This pattern is consistent with overlapping rather than additive representations of junctional anatomy (*Table 3*).

Exploratory Technical Panel

Bougie caliber, distance from the resection line to the angle of His, stapler-cartridge count, and operative time were similar between incident and non-incident groups (*Table 4*). Univariable ORs per one SD were 0.86 (95% CI 0.60-1.22), 1.00 (0.70-1.42), 1.11 (0.78-1.58), and 1.08 (0.76-1.53), respectively. A joint model including all four measures and hiatal hernia included 136 patients; none of the technical confidence intervals excluded 1, while the hiatal-hernia estimate remained elevated (OR mutually adjusted within the technical model 5.44, 95% CI 2.20-13.45). These estimates indicate no detected technical signal in the recorded ranges; they do not demonstrate that construction choices are equivalent or irrelevant, and they say nothing about the antral starting point, which was not evaluable.

Sensitivity Analyses

For LA-B-or-higher, hiatal hernia was associated with 8/33 versus 7/106 events (OR 4.53, 95% CI 1.50-13.67; Fisher p=0.009), and the OR per Hill grade was 2.55 (95% CI 1.25-5.19; p=0.010). Broader timing yielded 63/170 events (37.1%; 95% CI 30.2-44.5) and a fixed 6–18-month window 57/159 events (35.8%; 28.8-43.6);

Table 3. Baseline EGJ anatomy and incident esophagitis in the primary 9–15-month window (N=139).

Exposure or stratum	Events/total	Rate	Unadjusted OR (95% CI); p	Adjusted OR (95% CI); p
No hiatal hernia	28/106	26.4%	Reference	Reference
Hiatal hernia	20/33	60.6%	4.29 (1.89–9.74); 0.0006	4.34 (1.85–10.14); <0.001
Hill I	6/35	17.1%	—	—
Hill II	14/46	30.4%	—	—
Hill III	23/51	45.1%	—	—
Hill IV	5/7	71.4%	—	—
Hill grade, per one-grade increase	48/139	—	2.08 (1.34–3.23); 0.001	2.13 (1.36–3.35); <0.001

Separate adjusted models include age, sex, and preoperative BMI. In the exploratory unadjusted shared model, hiatal-hernia OR was 2.60 (95% CI 0.96–7.04; p=0.059) and Hill-grade OR 1.56 (0.92–2.64; p=0.095). In the demographically adjusted shared model, corresponding ORs were 2.45 (0.85–7.06; p=0.098) and 1.62 (0.93–2.80; p=0.086). Fisher p is shown for the unadjusted hernia contrast; logistic Wald p values otherwise.

Table 4. Exploratory technical measures and incident esophagitis in the primary window.

Technical measure	Incident mean ± SD	No incident mean ± SD	Univariable OR/SD (95% CI); p	Joint + HH OR/SD (95% CI); p
Bougie caliber, Fr	36.71 ± 1.82	36.99 ± 1.89	0.86 (0.60–1.22); 0.399	0.92 (0.63–1.35); 0.676
Distance to angle of His, cm	1.04 ± 0.33	1.04 ± 0.27	1.00 (0.70–1.42); 0.994	0.96 (0.66–1.41); 0.840
Stapler cartridges, n	5.08 ± 1.01	4.98 ± 1.03	1.11 (0.78–1.58); 0.562	1.34 (0.90–2.00); 0.147
Operative time, min	108.9 ± 22.0	107.0 ± 24.9	1.08 (0.76–1.53); 0.668	1.06 (0.72–1.57); 0.759

N=139 except distance to angle of His and the joint model (N=136; three missing values). Each OR is per one within-cohort SD. The joint model includes all four technical measures and hiatal hernia; the latter had OR 5.44 (95% CI 2.20–13.45; p<0.001), mutually adjusted within this technical model. Two registry fields intended to characterize the antral starting point were excluded on measurement-validity grounds and are not reported. Absence of a detected association is not evidence of equivalence. HH: hiatal hernia.

anatomy estimates remained directionally consistent in both. Restriction to the 220 of 228 target-due patients with a full 456-day opportunity retained 131 EGDs and 45 events (34.4%, 95% CI 26.8-42.8), with hiatal-hernia OR 4.51 (95% CI 1.93-10.54) and 2.12 (1.34-3.36) per Hill grade. Additional adjustment for age, sex, preoperative BMI, and baseline GERD-HRQL left both anatomical associations essentially unchanged (hiatal hernia OR 3.57, 95% CI 1.46-8.71, p=0.005; per Hill grade OR 2.12, 95% CI 1.34-3.37, p=0.001). No anatomy model contained more than five predictor terms plus the intercept. Restriction to procedures performed from February 2023 onward, when 61/62 eligible patients were examined, yielded 19/61 events (31.1%; 95% CI 20.9-43.6), with hiatal-hernia OR 8.25 (95% CI 2.35-28.96) and 3.86 (1.65-9.02) per Hill grade; the corresponding estimates for the earlier period were 29/78 (37.2%; 27.3-48.3), 2.70 (0.88-8.29) and 1.56 (0.89-2.72). The intervals overlap widely and the study cannot establish that the periods differ. The symptom-plus-endoscopy composite endpoint, rederived on the same risk set under identical timing rules, occurred in 17/71 evaluable patients (23.9%; 95% CI 15.5-35.0) (*Table 5; Fig. 2*). For transparency concerning the superseded composite construct, the isolated symptomatic transition from preoperative GERD-Q below 8 to 8 or more occurred in 26/72 patients with both measurements available (36.1%), based on questionnaire data of mixed provenance; it is reported here for completeness and was not treated as an outcome of the revised analysis.

Discussion

This analysis asks what can be known before the operation. Among patients with normal baseline mucosa who were examined at one year, new-onset erosive esophagitis occurred in 48/139 (34.5%), the strongest available correlate being junctional anatomy recorded at the preoperative endoscopy, with a graded rise across Hill grade and a higher rate in the presence of a hiatal hernia. Thirty-day outcomes in the complete cohort of 250 procedures are a secondary descriptive result (*Table 2*).

Table 5. Sensitivity analyses for incident endoscopic esophagitis and baseline anatomy.

Analysis	Events/total	Rate (95% CI)	Hiatal hernia OR (95% CI)	Hill grade OR (95% CI)
Primary: any LA A–D, 9–15 months	48/139	34.5% (27.1–42.8)	4.29 (1.89–9.74)	2.08 (1.34–3.23)
Clinically stricter: LA-B–D	15/139	10.8% (6.6–17.0)	4.53 (1.50–13.67)	2.55 (1.25–5.19)
Broader timing: EGD closest to 1 year	63/170	37.1% (30.2–44.5)	3.48 (1.69–7.18)	2.03 (1.37–3.00)
Fixed 6–18-month window	57/159	35.8% (28.8–43.6)	3.38 (1.61–7.11)	2.12 (1.40–3.19)
Full 456-day observation opportunity	45/131	34.4% (26.8–42.8)	4.51 (1.93–10.54)	2.12 (1.34–3.36)
Adjusted for baseline GERD-HRQL	48/139	34.5% (27.1–42.8)	3.57 (1.46–8.71)	2.12 (1.34–3.37)
Symptom-plus-endoscopy composite endpoint	17/71	23.9% (15.5–35.0)	—	—
Near-complete capture, Feb 2023 onward	19/61	31.1% (20.9–43.6)	8.25 (2.35–28.96)	3.86 (1.65–9.02)
Earlier period, 2020 to Jan 2023	29/78	37.2% (27.3–48.3)	2.70 (0.88–8.29)	1.56 (0.89–2.72)
Extreme case: all 89 missing non-events	48/228	21.1%	—	—
Extreme case: all 89 missing events	137/228	60.1%	—	—

The broader-timing analysis selected the valid postoperative EGD with actual date closest to 365.25 days among target-due baseline-normal patients (median 365 days; range 160–770). The fixed-window analysis used 183–548 days (median 365 days). The full-opportunity analysis required ≥ 456 days from index admission to the censoring date; 131 of those 220 patients had a valid window EGD, out of the 228 patients who had reached the 12-month target. The two period rows restrict the analysis by date of surgery and add no parameters; their intervals overlap widely and the study cannot establish that the periods differ. The GERD-HRQL row is additionally adjusted for age, sex, and preoperative BMI; all other ORs are unadjusted. No model contained more than five predictor terms plus the intercept. The composite endpoint had separate eligibility and event criteria. Eligibility required normal baseline mucosa, preoperative GERD-Q below 8, an available 12-month GERD-Q, and a valid 274–456-day EGD, which 71 of the 139 primary-window patients met; the event required both transition to GERD-Q of 8 or more and incident LA-grade esophagitis, met by 17 of those 71. Wilson intervals are shown where displayed. Extreme-case rows are identification bounds, not probability models.

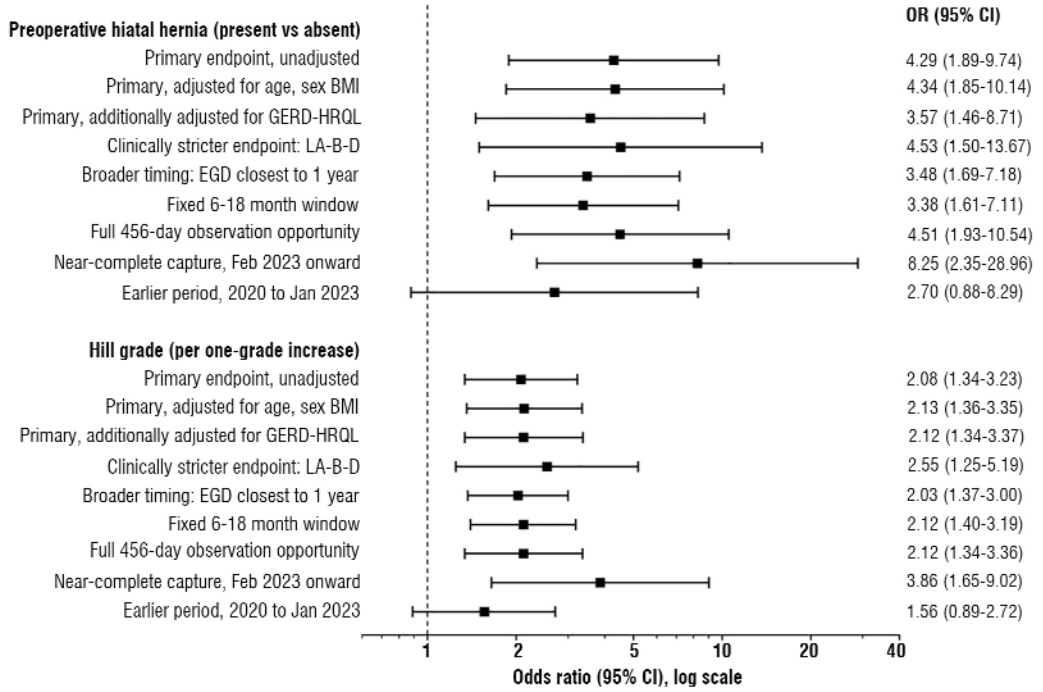


Figure 2. Associations of preoperative hiatal hernia and Hill grade with incident endoscopic esophagitis in primary and sensitivity analyses. Separate adjusted primary models include age, sex, and preoperative BMI. The near-complete-capture row comprises the same 61 patients shared with a separately reported analysis and all 19 of its events, so it is an internal check on missingness rather than an independent replication. The two period rows are shown together; their intervals overlap widely and the study cannot establish that the periods differ. The forest plot displays association estimates, not causal effects or externally validated prediction.

Endpoint language matters. Most incident lesions were LA-A (33/48), while LA-B-or-higher occurred in 15/139 (10.8%), all of them LA-B. Lyon Consensus 2.0 treats LA-B-D as conclusive endoscopic GERD but isolated LA-A as non-conclusive (6), so both are reported. The anatomy associations persist for the stricter endpoint, albeit with wide intervals from 15 events.

Both variables were associated when modeled separately, consistent with previous endoscopy-based studies (14-16), including prospective multicenter data linking Hill III-IV to objectively defined GERD (16). This smaller series reproduces the direction in a normal-baseline, actual-time risk set. The seven Hill-IV patients produced an imprecise 5/7 (71.4%) event rate, precluding a treatment threshold.

The hiatal-hernia association cannot be interpreted as evidence that crural repair failed or caused esophagitis. Hiatal dissection and crural repair were perfectly coincident in the registry. All 65 patients with preoperative endoscopic hiatal hernia underwent repair, while 10 additional repairs occurred without a documented preoperative hernia. Consequently, no untreated-hernia comparator exists and the independent effect of repair cannot be estimated. What the operative record does show is that a negative preoperative endoscopic report did not preclude subsequent crural repair following intraoperative assessment. Eight of these 10 were operated before February 2023 and two afterwards; with 8 of 49 repairs against 2 of 26 the difference is not statistically significant (Fisher p=0.48). These findings indicate discordant but overlapping anatomical descriptors; they do not establish the diagnostic accuracy of endoscopy or the incremental predictive value of Hill grade, and in the shared model both descriptors attenuate. They are a statement about the preoperative information available, not about which repair to perform.

The exploratory technical panel requires restraint: absence of detectable association across four registry measures differs from proof of equivalence. A single-team design reduces between-operator heterogeneity but restricts exposure variation and external transportability (21). Distance measurements were intraoperative estimates; two antral-start fields were excluded on measurement-validity grounds, so the antral starting point was not evaluable; and 48 events offer limited power. These limitations preclude the claim that "technique does not matter."

Phenotype-guided stratification has been proposed as a framework for personalized surgery in other fields; here, however, the relevant phenotype is anatomical and the present data support risk characterization rather than selection of a specific antireflux procedure (22).

Incomplete endpoint capture is the main qualification of these results, and it was strongly concentrated in the earlier calendar period: capture was 78/166 (47.0%) before February 2023, from which date scheduled follow-up endoscopy became routine, and 61/62 (98.4%) afterwards. The association remained directionally concordant in the near-complete-capture period, making differential endpoint capture alone unlikely to explain it. The intervals overlap widely, so the study cannot establish that the periods differ, and other forms of selection or confounding are not excluded. Extreme-case bounds remain wide (21.1-60.1%), so a population incidence is not identified.

Other limitations include the retrospective single-center design in a private bariatric practice; morbidity reporting restricted to 30 days, since later events managed elsewhere may not be captured; unknown endoscopist blinding and no central EGD adjudication; lack of systematic pH-impedance monitoring, which was performed in no patient (0/250), and of manometry, which was available preoperatively in only 5/250; no standardized proton-pump-inhibitor record around EGD; small numbers for LA-B and Hill IV; residual confounding; and no external validation. Registry conflicts were adjudicated against original source documents by the operating surgeon rather than by an independent panel; the registry holds no per-record locator, so provenance was reconstructed by examination date. Symptom data from the earlier period were partly assembled after the index episode, so baseline symptom scores there may be subject to recall effects; the endoscopic endpoint, derived entirely from dated endoscopy reports, is not.

The principal strengths are a normal-mucosa baseline risk set, a fixed actual-time primary window, separate LA-B analysis, adjudication of registry conflicts against original source documents, and a period of near-complete ascertainment in which the association could be checked.

Conclusions

Among patients with normal baseline mucosa who completed follow-up endoscopy, preoperative hiatal hernia (20/33 versus 28/106) and increasing Hill grade were associated with new-onset erosive esophagitis after LSG, which occurred in 48/139 (34.5%), with LA-B-or-higher in 15/139 (10.8%). Association estimates remained elevated in the near-complete-capture period (19/61 events; hiatal-hernia OR 8.25 and 3.86 per Hill grade), although with wide confidence intervals, and endpoint capture was incomplete overall, with 89 of 228 target-due patients lacking a window examination. Ten patients underwent crural repair after intraoperative assessment despite no preoperative endoscopic diagnosis. In the complete operative cohort, 30-day major morbidity was 7/250 (2.8%), staple-line leak 2/250 (0.8%), and mortality 0/250 (0%). These findings support careful preoperative anatomical characterization and deliberate intraoperative assessment, but do not identify an optimal hiatal repair or antireflux modification; no association was detected for four selected operative measures, and this does not establish technical equivalence.

Authors' Contributions

R.D.B. conceived the study, curated and analyzed the data, performed the formal analysis, and drafted the manuscript. E.D. and R.C.P. contributed to methodology, validation and supervision. All authors contributed to data acquisition, source validation and/or clinical interpretation as applicable, critically revised the manuscript, approved the final version, and agree to be accountable for all aspects of the work.

Conflicts of Interest and Source of Funding

The authors declare no conflicts of interest. This research received no external funding.

Competing Interests

The authors declare no competing interests.

Data Availability

The de-identified patient-level data are not publicly posted because of institutional and privacy restrictions. A methodologically sufficient data dictionary and de-identified analytic extract may be made available by the corresponding author on reasonable request and subject to ethics and institutional approval.

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