

Linear versus Circular Stapled Gastrojejunostomy in Minimally Invasive Roux-en-Y Gastric Bypass: A nationwide Swiss Registry study (2015-2022)

Yanic Ammann

yanic.ammann@kshg.ch

Kantonsspital St. Gallen

Rene Warschkow

Kantonsspital St. Gallen

Marie Klein

Kantonsspital St. Gallen

Romano Schneider

University Digestive Health Care Center Basel

Beat Müller

University Hospital of Basel

Loriana Lisarelli

Kantonsspital St. Gallen

Ignazio Tarantino

Kantonsspital St. Gallen

Patrick Folie

Kantonsspital St. Gallen

Research Article

Keywords:

Posted Date: August 12th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10218635/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at Obesity Surgery on October 16th, 2026.
See the published version at <https://doi.org/10.1007/s11695-026-08982-x>.

Abstract

Background

The impact of stapling technique on early postoperative outcomes in minimal invasive Roux-en-Y gastric bypass (RYGB) remains incompletely understood. This study aimed to compare short-term postoperative outcomes following linear versus circular gastrojejunostomy.

Methods

This retrospective population-based study analysed data from the Swiss national inpatient registry between 2015 and 2022. The primary endpoint was overall postoperative complications. Secondary endpoints were individual postoperative complications, reoperation, and length of hospital stay (LOS). Associations between stapling technique and postoperative outcomes were assessed using generalized additive regression models.

Results

A total of 21,375 cases were included. Of these, 18,202 cases (85.2%) underwent a linear whereas 3,173 (14.8%) underwent a circular gastrojejunostomy. The overall complication rate was 8.1% ($n = 1,724$). Stapling technique was not associated with overall postoperative complications (odds ratio [OR] for circular vs. linear = 1.087, $p = 0.238$) or reoperation (OR = 1.043, $p = 0.691$). Compared with linear, circular stapling was associated with higher rates of surgical site infection (OR = 2.330, $p < 0.001$), urinary tract infection (OR = 1.643, $p = 0.041$), urinary retention (OR = 1.729, $p = 0.010$), ICU admission (OR = 2.650, $p < 0.001$), and prolonged LOS both at the 50th percentile (3 days, OR = 1.103, $p = 0.019$) as well as at the 90th percentile (5 days, $p = 0.005$). Secondary RYGB procedures were associated with the highest risk of overall complications (OR = 2.955, $p < 0.001$).

Conclusion

Neither linear nor circular stapling demonstrated clear superiority. However, circular stapling was associated with higher rates of several specific postoperative complications and prolonged LOS. Secondary RYGB procedures carried a substantially increased risk of postoperative complications.

Registry: ClinicalTrials.gov, TRN: NCT07483957, Registration date: 17 March 2026.

Key points

- Linear and circular gastrojejunostomy showed comparable rates of overall short-term postoperative complications after minimally invasive Roux-en-Y gastric bypass.
- Circular gastrojejunostomy was associated with higher odds of surgical site infection, urinary tract infection, urinary retention, ICU admission, and prolonged length of hospital stay.

- Secondary Roux-en-Y gastric bypass was the strongest independent predictor of postoperative complications.

Introduction

Bariatric surgery has become one of the preferred options for the treatment of severe obesity and its comorbidities in the Western world.(1–3) In Switzerland, approximately 5,000 annual bariatric operations are performed exclusively in centres certified by the Swiss Society of the Study of Morbid Obesity and Metabolic Disorders (SMOB).(4) Among the different bariatric surgical procedures, minimally invasive Roux-en-Y gastric bypass (RYGB) remains one of the most frequently performed operations.(5) A critical step in this operation is the creation of the gastrojejunal anastomosis.(6) This can be done using either a linear or a circular stapler. The optimal method remains a matter of debate. The linear technique is technically less demanding, requires smaller incisions, and is therefore associated with shorter operative times.(7) The circular technique benefits from a standardised anastomotic diameter with potentially higher reproducibility.(8) No difference in long-term weight loss has been demonstrated between the two techniques to date.(9–13) The linear technique has been linked to marginal ulcers, while the circular technique has been associated with higher rates of stenosis and incisional hernia. The associations with other long-term adverse events such as internal hernias remain controversial.(12, 14–17) However, international studies have suggested that the linear technique is associated with more favourable short-term outcomes, including shorter operation times, lower rates of wound complications, and postoperative bleeding. Both techniques are used in Switzerland, but Swiss national data on this topic are scarce. Given the high annual case volume of bariatric surgery in Switzerland and the inconsistent international evidence, a systematic comparison of these two techniques is clinically relevant.

This retrospective registry study provides nationwide Swiss data on short-term postoperative outcomes after RYGB between 2015 and 2022. It aims to compare linear and circular gastrojejunal anastomosis techniques in terms of postoperative complications, reoperation rate, and length of hospital stay (LOS).

Materials and Methods

Study design and variables

This was a retrospective population-based analysis using data from the Swiss national inpatient registry covering the period between 2015 and 2022. The anonymised data were obtained from the Swiss Federal Statistical Office (FSO), which maintains a mandatory nationwide inpatient reporting system, via a data contract for the one-time delivery and use of individual data (without personal identification) in Switzerland. The data included detailed information on all inpatient cases treated at Swiss hospitals between 2015 and 2022 as described in the Supplementary Material.

Case selection

The cases were selected according to the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) and the Swiss Classification of Surgical Interventions (CHOP) codes.(18, 19) All cases with an ICD-10 code of E66 (obesity) who underwent RYGB were selected. RYGB procedures were selected based on the following CHOP codes: 44.31.12 (primary laparoscopic proximal gastric bypass), 44.31.22 (primary laparoscopic distal gastric bypass), 44.31.42 (primary laparoscopic Roux-en-Y gastric bypass), 44.31.14 (secondary laparoscopic proximal gastric bypass after sleeve resection), and 44.31.16 (secondary laparoscopic proximal gastric bypass after gastric banding). Linear stapled gastrojejunostomy was identified using CHOP codes 00.9A.13 or 00.9A.14, whereas circular stapled gastrojejunostomy was identified using CHOP codes 00.9A.11 or 00.9A.12.

Cases with incomplete documentation, age younger than 20 years, hospitalisation at institutions other than general or surgical hospitals, Omega-loop gastric bypass, emergency admission, open gastric bypass, and missing stapler codes were excluded. Incomplete documentation occurred due to the FSO's strict calendar year data collection (from January 1 to December 31). Consequently, data from cases hospitalized overnight on December 31 were incomplete.(20) The inclusion of cases aged 18 and 19 years was not possible due to the registry's five-year age group classification. Hospitals other than general or surgical hospitals were excluded because cases treated at these institutions generally have fewer comorbidities, which could have introduced selection bias.(21) Cases without documented stapler codes either represent hand-sewn anastomoses or reflected incomplete procedural coding.

Primary and secondary endpoints

The primary endpoint of this study was overall 30-day postoperative complications. The analysed postoperative complications are listed in Table 2.

Secondary endpoints were individual 30-day postoperative complications, 30-day reoperation, and length of hospital stay (LOS). A reoperation was identified using CHOP code 00.99.10. LOS was assessed at the 50th percentile (representing the typical postoperative course) and the 90th percentile (representing a prolonged postoperative course).

Additional objectives included analysing temporal trends in the use of linear and circular staplers, as well as annual trends in sociodemographic and clinical characteristics, including the number of operations, the number of hospitals performing RYGB, the mean annual case volume, age, Charlson Comorbidity Index (CCI), sex, intensive care unit (ICU) admission, nationality (Swiss vs. foreign), insurance status (compulsory vs. supplementary), robotic approach (CHOP code 00.99.50), surgical status (primary vs. secondary), bypass configuration (proximal vs. distal), and LOS between 2015 and 2022.(22) The CCI and ICU admission were defined as described in the Supplementary Material.

Statistical analysis

Statistical analyses were performed using R statistical software (<https://www.r-project.org>). Continuous data were expressed as mean $\pm$ standard deviation (SD), interquartile range (IQR) and range. In the descriptive analysis, proportions were compared using the chi-square test, and continuous variables were compared with Student's t tests and the Mann–Whitney U test, as appropriate. A two-sided p-value of less than 0.05 was considered significant. Due to the large number of cases, the standardised mean difference (SMD) was also used to compare groups. An $\text{SMD} \leq 0.2$ was defined as indicating no difference, an $\text{SMD} > 0.2$ as a small, an $\text{SMD} > 0.5$ as a moderate, and an $\text{SMD} > 0.8$ as a large difference.

The BMI was classified according to the World Health Organization (WHO) into grade 1 (ICD-10 codes E66.00, E66.10, E66.20, E66.80, E66.90; numeric BMI of 32.5 kg/m^2), grade 2 (ICD-10 codes E66.01, E66.11, E66.21, E66.81, E66.91; numeric BMI of 37.5 kg/m^2), and grade 3 (ICD-10 codes E66.02, E66.12, E66.22, E66.82, E66.92; numeric BMI of 45 kg/m^2). From 2022 onwards, WHO grade 3 was additionally divided into three subgroups: 3a (BMI 40.0 to 49.9 kg/m^2 ; ICD-10 codes E66.06, E66.16, E66.26, E66.86, E66.96; numeric BMI of 45 kg/m^2), 3b (BMI 50.0 to 59.9 kg/m^2 ; ICD-10 codes E66.07, E66.17, E66.27, E66.87, E66.97; numeric BMI of 55 kg/m^2), and 3c (BMI $\geq 60.0 \text{ kg/m}^2$; ICD-10 codes E66.08, E66.18, E66.28, E66.88, E66.98; numeric BMI of 65 kg/m^2).⁽²³⁾ For regression analyses, numeric BMI was assigned using the category midpoint.

The associations between anastomosis type (linear vs. circular) and postoperative complications, reoperation, and LOS were assessed using generalized additive regression models (GAMs). The confounding variable set included surgical status (primary vs. secondary), robotic approach (yes vs. no), bypass configuration (proximal vs. distal), annual hospital volume (continuous, per 10 additional patients), sex (male vs. female), nationality (Swiss vs. foreign), insurance status (compulsory vs. supplementary [semi-private and private]), numeric BMI (continuous), hospital type (university vs. tertiary vs. other), age (penalized spline), year of operation (penalized spline), and CCI (penalized spline).^(24, 25)

Temporal trends were assessed using the nonparametric Mann-Kendall trend test from the R package.⁽²⁶⁾ Kendall's tau ranges between -1 (perfect descending trend) and $+1$ (perfect ascending trend) with 0 representing no trend at all.⁽²⁷⁾

Ethics

This study was approved by the Ethics Committee of Eastern Switzerland (BASEC No. B2025-00702), was registered at ClinicalTrials.gov (NCT07483957), and was compliant with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.⁽²⁸⁾ The study conformed to the principles of the Declaration of Helsinki. There were no deviations from the published protocol.

Results

Case selection

The dataset provided by the FSO contained data on 11,663,470 cases. 203,955 cases were excluded due to incomplete documentation, 1,495,476 due to age younger than 20 years, and 1,107,497 due to treatment at institutions other than general or surgical hospitals. A total of 8,831,429 cases had no gastric bypass, 314 cases had an Omega-loop gastric bypass, 380 cases were emergency operations, and 306 cases had an open gastric bypass. No stapler was coded in 2,738 cases. The final study population included 21,375 patients (Fig. 1). A linear gastrojejunal anastomosis was created in 18,202 cases (85.2%) and a circular anastomosis in 3,173 cases (14.8%).

Baseline characteristics

Linear anastomosis was performed more frequently than circular anastomosis ($n = 18,202$ [85.2%] vs. $n = 3,173$ [14.8%]). Case baseline characteristics are presented in Table 1. RYGB was predominantly performed in otherwise healthy Swiss women (76.5% female, 72.7% Swiss) with a mean age of 42.1 years, a mean numeric BMI of 41.9 kg/m^2 , and a mean CCI of 0.2. Proximal gastric bypass configuration (97.6% vs. 88.2%, $\text{SMD} = 0.370$, $p < 0.001$) and robotic approach (6.8% vs. 0.6%, $\text{SMD} = 0.334$, $p < 0.001$) were significantly more common in cases with linear anastomosis. There were no other clinically relevant baseline differences between the two groups.

Table 1
Case baseline characteristics

Variable	Category	Total n = 21,375	Linear n = 18,202	Circular n = 3,173	SMD	p value
Age (years)	Mean (SD)	42.1 (11.9)	42.1 (11.9)	42.4 (11.8)	0.024	0.223 A)
	Median [IQR]	42.0 [32.0 to 52.0]	42.0 [32.0 to 52.0]	42.0 [32.0 to 52.0]		
	Range	22.0–77.0	22.0–77.0	22.0–77.0		
Sex	Male	5,024 (23.5%)	4,225 (23.2%)	799 (25.2%)	0.046	0.016 B)
	Female	16,351 (76.5%)	13,977 (76.8%)	2,374 (74.8%)		
BMI (WHO)	Grade 1	514 (2.4%)	427 (2.3%)	87 (2.7%)	0.025	< 0.001 C)
	Grade 2	8,296 (38.8%)	7,184 (39.5%)	1,112 (35.0%)	-0.092	
	Grade 3	11,109 (52.0%)	9,298 (51.1%)	1,811 (57.1%)	0.120	
	Grade 3a	1,206 (5.6%)	1,084 (6.0%)	122 (3.8%)	-0.098	
	Grade 3b	168 (0.8%)	144 (0.8%)	24 (0.8%)	-0.004	
	Grade 3c	15 (0.1%)	14 (0.1%)	1 (0.0%)	-0.020	
	Unknown	67 (0.3%)	51 (0.3%)	16 (0.5%)	0.036	
Numeric BMI (kg/m ²)	Mean (SD)	41.9 (4.1)	41.8 (4.1)	42.1 (4.1)	0.064	< 0.001 A)
	Median [IQR]	45.0 [37.5 to 45.0]	45.0 [37.5 to 45.0]	45.0 [37.5 to 45.0]		
	Range	32.5–65.0	32.5–65.0	32.5–65.0		
Nationality	Foreign	5,833 (27.3%)	4,863 (26.7%)	970 (30.6%)	0.085	< 0.001 B)
	Swiss	15,542 (72.7%)	13,339 (73.3%)	2,203 (69.4%)		
Insurance status	Compulsory	19,532 (91.4%)	16,624 (91.3%)	2,908 (91.6%)	0.011	0.556 B)

Variable	Category	Total n = 21,375	Linear n = 18,202	Circular n = 3,173	SMD	p value
	Supplementary	1,843 (8.6%)	1,578 (8.7%)	265 (8.4%)		
CCI	Mean (SD)	0.2 (0.5)	0.2 (0.5)	0.1 (0.5)	-0.040	0.031 A)
	Median [IQR]	0.0 [0.0 to 0.0]	0.0 [0.0 to 0.0]	0.0 [0.0 to 0.0]		
	Range	0.0–6.0	0.0–6.0	0.0–5.0		
Type of hospital	University	1,980 (9.3%)	1,535 (8.4%)	445 (14.0%)	0.178	< 0.001 B)
	Tertiary	13,229 (61.9%)	11,437 (62.8%)	1,792 (56.5%)	-0.130	
	Other	6,166 (28.8%)	5,230 (28.7%)	936 (29.5%)	0.017	
Annual hospital case	Mean (SD)	91.0 (58.7)	91.8 (61.5)	86.3 (38.7)	-0.107	< 0.001 A)
volume	Median [IQR]	82.0 [48.0 to 120.0]	80.0 [47.0 to 123.0]	94.0 [66.0 to 115.0]		
	Range	1.0-272.0	1.0-272.0	1.0-272.0		
Surgical status	Primary	20,312 (95.0%)	17,306 (95.1%)	3,006 (94.7%)	-0.015	0.415 B)
	Secondary	1,063 (5.0%)	896 (4.9%)	167 (5.3%)		
Bypass configuration	Proximal	20,561 (96.2%)	17,761 (97.6%)	2,800 (88.2%)	-0.370*	< 0.001 B)
	Distal	814 (3.8%)	441 (2.4%)	373 (11.8%)		
Robotic approach	No	20,125 (94.2%)	16,970 (93.2%)	3,155 (99.4%)	0.334*	< 0.001 B)
	Yes	1,250 (5.8%)	1,232 (6.8%)	18 (0.6%)		

Variable	Category	Total n = 21,375	Linear n = 18,202	Circular n = 3,173	SMD	p value
Bold indicates statistical significance ($p < 0.05$); * indicates a small effect size ($SMD > 0.2$) A): Mann-Whitney U test; B): Chi-square test; C) Chi-square test with Monte Carlo simulation SMD: Standardized mean difference; SD: Standard deviation; IQR: Interquartile range; CCI: Charlson Comorbidity Index						

Short-term postoperative outcomes

Short-term postoperative outcomes are presented in Table 2. Although several outcomes reached significance, ICU admission showed the only clinically relevant difference between the two groups (circular 25.6% vs. linear 11.5%, SMD 0.370, $p < 0.001$).

Table 2
Short-term postoperative outcomes

Variable	Category	Total n = 21,375	Linear n = 18,202	Circular n = 3,173	SMD	p value
Overall complications	Yes	1,724 (8.1%)	1,440 (7.9%)	284 (9.0%)	0.037	0.029 B)
Myocardial infarction (I21, I22)	I21, I22	4 (0.0%)	2 (0.0%)	2 (0.1%)	0.027	0.119 A)
Cardiac arrest	I46	8 (0.0%)	6 (0.0%)	2 (0.1%)	0.014	0.440 A)
Arterial fibrillation	I48	176 (0.8%)	158 (0.9%)	18 (0.6%)	-0.036	0.084 B)
Deep vein thrombosis Pulmonary embolism	I26.0, I26.9, I80.2	18 (0.1%)	14 (0.1%)	4 (0.1%)	0.015	0.390 A)
Pneumonia	J13-18, J85.1	87 (0.4%)	70 (0.4%)	17 (0.5%)	0.022	0.217 B)
Pleural effusion	J90, J91	74 (0.3%)	59 (0.3%)	15 (0.5%)	0.024	0.188 B)
Atelectasis	J98.1	89 (0.4%)	72 (0.4%)	17 (0.5%)	0.021	0.258 B)
Aspiration	J69.0, J69.8, J95.4	42 (0.2%)	33 (0.2%)	9 (0.3%)	0.021	0.230 B)
Pulmonary insufficiency/respiratory failure	J95.1, J95.2, J95.3, J96	104 (0.5%)	88 (0.5%)	16 (0.5%)	0.003	0.877 B)
ARDS	J80	9 (0.0%)	6 (0.0%)	3 (0.1%)	0.024	0.170 A)
Acute kidney injury	N17, N19	65 (0.3%)	59 (0.3%)	6 (0.2%)	-0.027	0.202 B)
Urinary tract infection	N10, N30.0, N30.9, N39.0	100 (0.5%)	76 (0.4%)	24 (0.8%)	0.044	0.010 B)
Urinary retention	R33	134 (0.6%)	103 (0.6%)	31 (1.0%)	0.047	0.007 B)
Anastomotic leakage	K91.83	104 (0.5%)	87 (0.5%)	17 (0.5%)	0.008	0.666 B)
Gastrointestinal ulcer	K25, K28	40 (0.2%)	37 (0.2%)	3 (0.1%)	-0.028	0.191 B)
Peritonitis/intra-abdominal abscess	K65	84 (0.4%)	73 (0.4%)	11 (0.3%)	-0.009	0.651 B)

Variable	Category	Total n = 21,375	Linear n = 18,202	Circular n = 3,173	SMD	p value
Delayed gastric emptying	K31.88	47 (0.2%)	41 (0.2%)	6 (0.2%)	-0.008	0.688 B)
Ileus	K56, K91.3	124 (0.6%)	105 (0.6%)	19 (0.6%)	0.003	0.881 B)
Bleeding	T81.0, S36.81	521 (2.4%)	439 (2.4%)	82 (2.6%)	0.011	0.561 B)
Shock	T81.1	6 (0.0%)	5 (0.0%)	1 (0.0%)	0.002	0.839 A)
Wound dehiscence	T81.3	22 (0.1%)	17 (0.1%)	5 (0.2%)	0.018	0.316 A)
SSI	T81.4, T89.02, L08.9	83 (0.4%)	57 (0.3%)	26 (0.8%)	0.068	< 0.001 B)
Intraoperative injury	T81.2	29 (0.1%)	26 (0.1%)	3 (0.1%)	-0.014	0.531 A)
Intraoperative retained foreign body	T81.5, T81.6	5 (0.0%)	3 (0.0%)	2 (0.1%)	0.023	0.188 A)
Other complications	J95.8, J95.9, K91.88, K91.9, T81.8, T81.9	291 (1.4%)	247 (1.4%)	44 (1.4%)	0.003	0.894 B)
Reoperation	Yes	723 (3.4%)	594 (3.3%)	129 (4.1%)	0.043	0.021 B)
ICU admission	Yes	2,883 (13.5%)	2,081 (11.4%)	802 (25.3%)	0.363*	< 0.001 B)
ICU admission (hours)	Mean (SD)	28.2 (57.2)	28.9 (60.7)	26.5 (46.9)	-0.045	0.033 C)
	Median [IQR]	22.0 [19.0 to 24.0]	22.0 [19.0 to 25.0]	22.0 [20.0 to 24.0]		
	Range	1.0- 1620.0	1.0- 1620.0	2.0- 1078.0		
Length of hospital stay (days)	Mean (SD)	3.9 (2.5)	3.9 (2.5)	4.1 (2.5)	0.071	< 0.001 C)
	Median [IQR]	3.0 [3.0 to 4.0]	3.0 [3.0 to 4.0]	4.0 [3.0 to 5.0]		

Variable	Category	Total n = 21,375	Linear n = 18,202	Circular n = 3,173	SMD	p value
	Range	0.0–85.0	0.0–85.0	1.0–52.0		
	LOS > 50th percentile (3.0 days)	10,681 (50.0%)	8,902 (48.9%)	1,779 (56.1%)	0.144	< 0.001 B)
	LOS > 90th percentile (5.0 days)	2011 (9.4%)	1659 (9.1%)	352 (11.1%)	0.066	< 0.001 B)
Mortality	Yes	4 (0.0%)	3 (0.0%)	1 (0.0%)	0.010	0.582 A)
Bold indicates statistical significance ($p < 0.05$); * indicates a small effect size ($SMD > 0.2$) A): Mid-p test; B): Chi-square test; C): Mann-Whitney U test; SMD: Standardized mean difference; SD: Standard deviation; IQR: Interquartile range; ARDS: Acute respiratory distress syndrome; SSI: Surgical site infection; ICU: Intensive care unit; LOS: Length of hospital stay;						

Postoperative Complications

The overall complication rate was 8.1% ($n = 1,724$). The type of anastomosis was not associated with overall postoperative complications (odds ratio [OR] for circular vs. linear = 1.087, 95% CI 0.946 to 1.250, $p = 0.238$). In multivariate GAM logistic regression, secondary RYGB, distal bypass configuration, male sex, treatment at university hospital, increasing age, and a higher CCI were independently associated with increased odds of overall complications (Table 3).

Table 3
Multivariable generalized additive logistic regression for overall postoperative complication

Variable	Category	OR	95% CI	p value
Anastomosis	Linear	Reference	-	-
	Circular	1.087	0.946 to 1.250	0.238
Surgical status	Primary	Reference	-	-
	Secondary	2.955	2.468 to 3.539	< 0.001
Robotic approach	No	Reference	-	-
	Yes	0.968	0.778 to 1.205	0.774
Bypass configuration	Proximal	Reference	-	-
	Distal	1.412	1.106 to 1.804	0.006
Annual hospital case volume	Continuous per 10 cases	0.991	0.981 to 1.001	0.071
Sex	Male	Reference	-	-
	Female	0.768	0.688 to 0.859	< 0.001
Nationality	Foreign	Reference	-	-
	Swiss	1.053	0.938 to 1.182	0.381
Insurance status	Compulsory	Reference	-	-
	Supplementary	1.070	0.904 to 1.267	0.432
Numeric BMI	Continuous	0.993	0.981 to 1.005	0.263
Hospital type	University	Reference	-	-
	Tertiary	0.731	0.621 to 0.861	< 0.001
	Other	0.657	0.550 to 0.785	< 0.001
Age	Penalized spline	-	-	< 0.001
Year of operation	Penalized spline	-	-	0.377

Variable	Category	OR	95% CI	p value
CCI	Penalized spline	-	-	< 0.001
Bold indicates statistical significance ($p < 0.05$) OR: Odds ratio; CI: Confidence interval; CCI: Charlson Comorbidity Index Age, year of operation, and CCI were modelled as penalized splines in the generalized additive model and therefore, odds ratios are not reported				

Compared with linear anastomosis, circular anastomosis was associated with higher odds of SSI (OR = 2.330, 95% CI 1.412 to 3.847, $p < 0.001$), urinary tract infection (OR = 1.643, 95% CI 1.021 to 2.645, $p = 0.041$), urinary retention (OR = 1.729, 95% CI 1.140 to 2.623, $p = 0.010$), and ICU admission (OR = 2.650; 95% CI 2.395 to 2.932, $p < 0.001$) (Table 4).

Table 4

Multivariable generalized additive logistic of the association between anastomotic technique and individual postoperative complications (linear anastomosis as reference)

Variable	OR (circular vs. linear anastomosis)	95% CI	p value
Myocardial infarction	5.163	0.660 to 40.398	0.118
Cardiac arrest	1.415	0.245 to 8.166	0.698
Arterial fibrillation	0.614	0.368 to 1.024	0.061
Deep vein thrombosis/pulmonary embolism	1.776	0.551 to 5.722	0.336
Pneumonia	1.371	0.793 to 2.371	0.259
Pleural effusion	1.315	0.716 to 2.415	0.378
Aspiration	1.511	0.698 to 3.273	0.295
Atelectasis	1.235	0.708 to 2.155	0.457
Pulmonary insufficiency/respiratory failure	1.324	0.752 to 2.330	0.331
ARDS	3.120	0.710 to 13.712	0.132
Acute kidney injury	0.595	0.251 to 1.410	0.238
Urinary tract infection	1.643	1.021 to 2.645	0.041
Urinary retention	1.729	1.140 to 2.623	0.010
Anastomotic leakage	1.094	0.642 to 1.864	0.742
Gastrointestinal ulcer	0.467	0.141 to 1.546	0.213
Peritonitis/intra-abdominal abscess	0.872	0.453 to 1.677	0.682
Delayed gastric emptying	0.716	0.299 to 1.713	0.453
Ileus	0.986	0.592 to 1.641	0.957
Bleeding	1.018	0.796 to 1.301	0.888
Shock	0.882	0.093 to 8.372	0.913
Wound dehiscence	1.811	0.624 to 5.256	0.274
SSI	2.330	1.412 to 3.847	< 0.001
Intraoperative injury	0.788	0.234 to 2.650	0.700
Intraoperative retained foreign body	4.250	0.662 to 27.283	0.127

Variable	OR (circular vs. linear anastomosis)	95% CI	p value
Other complications	1.042	0.740 to 1.466	0.814
ICU admission	2.650	2.395 to 2.932	< 0.001
Bold indicates statistical significance ($p < 0.05$) OR: Odds ratio; CI: Confidence interval; ICU: Intensive care unit; ARDS: Acute respiratory distress syndrome; SSI: Surgical site infection			

Reoperation

The overall reoperation rate was 3.4% ($n = 723$). The type of anastomosis was not associated with reoperation (OR = 1.043, 95% CI 0.849 to 1.281, $p = 0.691$). According to multivariate GAM logistic regression, secondary bypass, robotic approach, distal bypass configuration, foreign nationality, lower numeric BMI, and higher age were associated with increased odds of reoperation. Year of operation was modelled as a smooth term (Supplementary Material, Table S1).

Length of hospital stay

The mean LOS was 3.9 days (SD 2.5 days). Compared with linear anastomosis, circular anastomosis was associated with a 10.3% higher likelihood of LOS exceeding the 50th percentile (3 days; OR = 1.103, 95% CI 1.017 to 1.198, $p = 0.019$) and with a 20.2% higher likelihood of LOS exceeding the 90th percentile (5 days; OR = 1.202, 95% CI 1.058 to 1.366, $p = 0.005$). Except for surgical status (at the 50th percentile), sex, and university and tertiary hospitals, all other covariates were associated with prolonged LOS in both models (Supplementary Material, Tables S2 and S3).

Time trends between 2015 and 2022

The use of circular anastomosis declined sharply from 16.6% ($n = 399$) to 10.1% ($n = 248$) between 2015 and 2022 ($\text{tau} = -0.714$, $p = 0.013$) (Fig. 2).

Trend analysis showed a slight increase in the mean CCI (0.13 to 0.17, $\text{tau} = 0.571$, $p = 0.048$) and a marked increase in robotic approach (4.1% to 8.2%, $\text{tau} = 0.714$, $p = 0.013$). Conversely, ICU admission (16.2% to 9.4%, $\text{tau} = -0.714$, $p = 0.013$), the proportion of cases with Swiss nationality (79.6% to 69.2%, $\text{tau} = -0.786$, $p = 0.006$), supplementary insurance status (9.5% to 7.4%, $\text{tau} = -0.714$, $p = 0.013$), distal bypass configuration (3.6% to 2.0%, $\text{tau} = -0.643$, $p = 0.026$), and mean LOS (4.7 days to 3.4 days, $\text{tau} = -1.000$, $p < 0.001$) decreased significantly in the same time period (Table 5).

Table 5
Trend analysis

Variable	Sum-Average	2015	2022	Kendall's tau	p value
Number of operations	21'375	2'404	2'449	0.000	1.000
Number of hospitals	50.2	51	51	-0.124	0.688
Mean annual hospital volume	53.3	47.1	48.0	-0.036	0.901
Mean age (years)	42.1	42.1	42.5	-0.214	0.458
Mean CCI	0.16	0.13	0.17	0.571	0.048
Women (%)	76.5	77.4	74.2	-0.286	0.322
ICU admission (%)	13.4	16.2	9.4	-0.714	0.013
Swiss nationality (%)	72.8	79.6	69.2	-0.786	0.006
Supplementary insurance status (%)	8.6	9.5	7.4	-0.714	0.013
Robotic approach (%)	5.9	4.1	8.2	0.714	0.013
Secondary bypass (%)	5.0	6.0	5.2	0.000	1.000
Distal bypass configuration (%)	3.7	3.6	2.0	-0.643	0.026
Mean LOS (days)	3.9	4.7	3.4	-1.000	< 0.001
Bold indicates statistical significance (p < 0.05)					
CCI: Charlson Comorbidity Index; ICU: Intensive care unit; LOS: Length of hospital stay					

Discussion

This study demonstrated that anastomotic technique (linear versus circular gastrojejunostomy) was not associated with overall short-term postoperative complications after RYGB. Secondary RYGB was the strongest independent predictor of overall complications among all confounding variables. When individual complications were considered, linear gastrojejunostomy was associated with lower odds of SSI, urinary tract infection, urinary retention, prolonged LOS, and ICU admission.

Several studies have already investigated postoperative complications associated with linear and circular gastrojejunostomy after RYGB. The increased risk of wound complications, observed in the present study is evident in almost all analyses.(7, 8, 16, 29–31) This has been attributed to greater tissue trauma at the port site required for insertion of the circular stapler. Insertion of the circular stapler requires a 4–5 cm incision through the skin and abdominal wall in the left or right mid-abdomen, which represents the typical site of SSI. Since fascial closure of small port sites is often omitted in obese patients (backdrop phenomenon), closure of the larger abdominal wall defect after circular stapler insertion may contribute to the higher SSI rate. The extraction of the orally inserted stapler head may

additionally contaminate the subcutaneous tissue at the port site. In line with this hypothesis, a study from the US showed a lower SSI rate with the circular technique when the anvil was retrieved enterically using a specimen bag followed by povidone-iodine irrigation.(32) Linear gastrojejunostomy was associated with lower postoperative CRP levels (day 1: 72.8 mg/l vs. 33.3 mg/l, $p < 0.001$; day 3: 106.2 mg/l vs. 53.3 mg/l, $p < 0.001$) and lower postoperative pain (opioid consumption per day 1: 19.7 units vs. 6.4 units, $p < 0.001$). These findings may reflect greater surgical trauma to the abdominal wall in patients undergoing circular compared with linear gastrojejunostomy. The higher pain level, resulting in an increased use of opioids, together with the longer operation time associated with circular gastrojejunostomy, may lead to a higher rate of urinary catheter insertion and therefore may explain the association between the circular gastrojejunostomy and urinary retention and infection observed in this study.(16, 30, 33) However, because operation time was not available in the registry, this hypothesis remains speculative. Alternatively, these findings may reflect differences in perioperative care pathways or urinary catheterization policies rather than the anastomotic technique itself, and residual confounding cannot be excluded. In line with this reasoning, Berglund et al. observed a significant but clinically small increase in length of stay associated with urinary catheter use (1.7 vs. 1.5 days, $p = .001$) in a propensity-matched cohort; however, the modest effect size warrants cautious interpretation.(34)

Postoperative bleeding was not associated with anastomotic technique in this study. This contrasts with the current scientific literature. A large analysis ($n = 9,904$; 2006–2010) from Michigan, USA, in which circular gastrojejunostomy was the preferred technique (66%), reported higher rates of postoperative haemorrhage (2.9% vs. 1.2%, $p < 0.001$) in patients undergoing circular gastrojejunostomy.(30) It should be noted, that the Michigan cohort reflects data from 2006 to 2010. Given the substantial technological advancements in stapling devices over the past decade, improvements in staple formation and haemostatic performance may partially explain why no relevant difference in postoperative bleeding was observed in our contemporary cohort (2015–2022). A nationwide analysis of 12,468 patients from the Dutch Audit of Treatment of Obesity also reported a higher rate of major postoperative bleeding in patients undergoing circular gastrojejunostomy (2.4% vs. 1.2%, $p = 0.002$).⁽⁹⁾ However, no in-depth statistical analyses beyond descriptive comparisons were performed in these two studies. A third nationwide analysis from Sweden, including 34,284 patients treated between 2007 and 2013, demonstrated higher adjusted odds for postoperative haemorrhage in patients undergoing circular gastrojejunostomy (OR = 1.85, 95% CI 1.16 to 2.94).⁽²⁹⁾ The small proportion of circular gastrojejunostomy ($n = 542$, 1.6%), performed predominantly at three hospitals, must be taken into account when interpreting these results. The marked imbalance in group size and centre distribution may have introduced selection bias, centre effects, and residual confounding.⁽³⁵⁾ Furthermore, only a limited number of baseline characteristics (only gender, age, BMI, and diabetes) and postoperative short-term outcomes were analysed systematically, which may have resulted in residual confounding due to unmeasured variables. A Chinese meta-analysis published in 2022 included 54,530 oncologic and bariatric patients undergoing laparoscopic gastric surgery with stapled anastomosis.⁽³¹⁾ A subgroup analysis of 51,547 patients undergoing bariatric surgery (linear gastrojejunostomy: $n = 41,256$ [80.0%], circular gastrojejunostomy: $n = 10,291$ [20.0%]) showed that linear gastrojejunostomy was associated

with lower rates of postoperative haemorrhage (OR = 0.495, $p < 0.001$). However, the term “postoperative haemorrhage” was not clearly defined by the authors. Only five of the 32 included studies reported anastomotic bleeding as a separate complication. All investigated oesophagojejunostomy or gastroduodenostomy in patients with gastric cancer between 2008 and 2018. In the remaining studies, anastomotic bleeding was grouped together with anastomotic leakage and anastomotic stricture under the composite endpoint anastomotic complications. Several technical mechanisms may explain the higher bleeding rates reported after circular gastrojejunostomy. The circular stapler creates a full-thickness ring resection, transecting a larger amount of tissue and more submucosal vessels simultaneously.(36) Furthermore, tissue compression may be less uniform in a thick gastric wall, resulting in less reliable vessel sealing, particularly because crossing staple lines are more common with circular gastrojejunostomy.(33, 37) In contrast, the staple line of a linear gastrojejunostomy can be inspected more easily intraoperatively, facilitating immediate haemostasis. Whether technical modifications, such as staple-line reinforcement, as proposed by Finks et al., can reduce postoperative bleeding remains uncertain.(30)

Considering all other complications, the results reported in the current scientific literature are inconsistent. Anastomotic leakage, for example, was associated with anastomotic technique only in the Swedish study (OR circular = 2.77, 95% CI 1.54 to 4.98) but not in the present study, the Dutch analysis (circular 0.1% vs. linear 0.4%, $p = 0.214$), the US study (circular 0.6% vs. linear 0.3%, $p = 0.38$), or the two meta-analyses (relative risk for linear gastrojejunostomy = 0.80, 95% CI 0.58 to 1.11; OR for linear gastrojejunostomy = 0.581, $p = 0.322$). (9, 16, 29–31)

The more frequent ICU admission and longer LOS in patients with circular gastrojejunostomy, as described above, should be interpreted with caution. Bariatric surgery is typically highly standardized and most bariatric centres have well-established postoperative treatment protocols with clear criteria for ICU admission and LOS. Both outcomes seem to depend more on institutional practice and patient characteristics than on the anastomotic technique itself. This interpretation is supported by the significant association of most confounding variables with LOS and the marked variation in ICU admission across hospital types. Therefore, ICU admission should not be regarded as a direct measure of postoperative complication severity but rather as a reflection of institutional care pathways.

Secondary RYGB was the strongest risk factor for postoperative overall complications, a result that is consistent with the current literature. For example, a French nationwide retrospective cohort study based on administrative discharge data from 2016 to 2022, comprising 284,271 bariatric procedures, reported a 58% increase of odds for severe complications (OR = 1.58, 95% CI 1.49 to 1.68, $p < 0.001$). (38) This is not surprising, as postoperative adhesions, scar formation, altered anatomy, longer operative times, and greater technical complexity are well-recognized challenges during revisional bariatric surgery. Particularly in patients with extremely high BMI and marked intra-abdominal fat distribution, primary sleeve gastrectomy followed by secondary bypass surgery is a well-established staged approach.(39) Development of a validated risk stratification model to identify patients in whom primary RYGB, when

technically feasible, is preferable to a staged approach with secondary bypass surgery would facilitate individualized bariatric decision-making.

Limitations

This study has several limitations. First, its retrospective registry study design. Second, the unequal distribution between the linear (85.2%) and circular gastrojejunostomy cohorts (14.8%), together with the temporal shift linear gastrojejunostomy, could introduce selection bias and reduce statistical precision because of marked imbalance in group size. Thirdly, BMI, postoperative weight loss, and long-term complication, especially stenosis and ulceration, which are crucial variables in bariatric surgery, were not included in the dataset provided by the FSO. Numeric BMI had to be extrapolated from the ICD-10 obesity categories and estimated for regression modelling. Fourth, surgical technique may vary considerably between individual hospitals. Detailed information on operative technique was unavailable: therefore, technique-specific analyses could not be performed.

Conclusion

Neither linear nor circular stapling demonstrated clear superiority with respect to overall short-term postoperative complications after minimally invasive RYGB. However, circular stapling was associated with higher rates of several specific postoperative complications and prolonged LOS. Linear stapled gastrojejunostomy appears to offer advantages with regard to SSI, urinary tract infection, and urinary retention. Secondary RYGB procedures carried a substantially increased risk of postoperative complications.

Declarations

Ethics approval and Clinical Trials registration

This study was approved by the Ethics Committee of Eastern Switzerland (BASEC B2025-00702), registered under ClinicalTrials.gov (NCT07483957), and is compliant with the Strengthening the Reporting of Observation in Epidemiology (STROBE) guidelines. It conforms to the provisions of the Declaration of Helsinki. There were no deviations from the published protocol.

Patient consent

The data was obtained anonymously from the Swiss Federal Statistics Office (FSO) via a data contract for the one-time delivery and use of individual data (without personal identification) in Switzerland.

Conflict of interest statement

None of the authors has any conflicts of interest to disclose.

Data availability statement

The anonymised case data supporting this study's findings can be obtained from the Swiss Federal Statistics Office (FSO).

Funding statement

No funding was received.

Publication statement

This paper is our own original work and does not duplicate any previously published work, including our own. It is not under consideration, in peer review, or accepted for publication in any other journal. It has not been published in any other journal.

Author Contribution

Yanic Ammann Conceptualisation, data curation, investigation, methodology, visualisation, writing - original draft
Rene Warschkow Formal analysis, software, validation, writing – review & editing
Marie Klein Writing – review & editing
Romano Schneider Writing – review & editing
Beat Müller Writing – review & editing
Loriana Lisarelli Writing – review & editing
Ignazio Tarantino Writing – review & editing
Patrick Folie Conceptualisation, resources, project administration, supervision, Writing – original draft

References

1. Alsuhibani A, Thompson JR, Wigle PR, Guo JJ, Lin AC, Rao MB, et al. Metabolic and Bariatric Surgery Utilization Trends in the United States: Evidence From 2012 to 2021 National Electronic Medical Records Network. *Ann Surg Open*. 2023;4(4):e317.
2. Ram Sohan P, Mahakalkar C, Kshirsagar S, Bikkumalla S, Reddy S, Hatewar A, et al. Long-Term Effectiveness and Outcomes of Bariatric Surgery: A Comprehensive Review of Current Evidence and Emerging Trends. *Cureus*. 2024;16(8):e66500.
3. Angrisani L, Santonicola A, Iovino P, Palma R, Kow L, Prager G, et al. IFSO Worldwide Survey 2020–2021: Current Trends for Bariatric and Metabolic Procedures. *Obes Surg*. 2024;34(4):1075–85.
4. SMOB SSftSoMOaMD-. Richtlinien zur operativen Behandlung von Übergewicht 2013 [Available from: <https://www.smob.ch/wp-content/uploads/2024/02/SMOB-Richtlinien-2023-07-01-Deutsch.pdf>
5. Brown WA, Liem R, Al-Sabah S, Anvari M, Boza C, Cohen RV, et al. Metabolic Bariatric Surgery Across the IFSO Chapters: Key Insights on the Baseline Patient Demographics, Procedure Types, and Mortality from the Eighth IFSO Global Registry Report. *Obes Surg*. 2024;34(5):1764–77.
6. Kaijser MA, van Ramshorst GH, Emous M, Veeger N, van Wagenveld BA, Pierie JEN. A Delphi Consensus of the Crucial Steps in Gastric Bypass and Sleeve Gastrectomy Procedures in the Netherlands. *Obes Surg*. 2018;28(9):2634–43.

7. Barr AC, Lak KL, Helm MC, Kindel TL, Higgins RM, Gould JC. Linear vs. circular-stapled gastrojejunostomy in Roux-en-Y gastric bypass. *Surg Endosc.* 2019;33(12):4098–101.
8. Major P, Janik MR, Wysocki M, Walędziak M, Pędziwiatr M, Kowalewski PK, et al. Comparison of circular- and linear-stapled gastrojejunostomy in laparoscopic Roux-en-Y gastric bypass: a multicenter study. *Wideochir Inne Tech Maloinwazyjne.* 2017;12(2):140–6.
9. Romeijn MM, van Hoef S, Janssen L, van de Pas KGH, van Dielen FMH, Luijten A, et al. Comparison of Linear versus Circular-Stapled Gastroenterostomy in Roux-en-Y Gastric Bypass: A Nationwide Population-Based Cohort Study. *Obes Surg.* 2021;31(8):3579–87.
10. Munoz-Flores F, Rodriguez-Quintero JH, Pechman D, Creange C, Zenilman A, Choi J, et al. Weight loss one year after laparoscopic roux-en-Y gastric bypass is not dependent on the type of gastrojejunal anastomosis. *Surg Endosc.* 2022;36(1):787–92.
11. Fehervari M, Alyaqout K, Lairy A, Khwaja H, Bonanomi G, Efthimiou E. Gastrojejunal Anastomotic Technique. Does It Matter? Weight Loss and Weight Regain 5 Years After Laparoscopic Roux-en-Y Gastric Bypass. *Obes Surg.* 2021;31(1):267–73.
12. Schneider R, Gass JM, Kern B, Peters T, Slawik M, Gebhart M, et al. Linear compared to circular stapler anastomosis in laparoscopic Roux-en-Y gastric bypass leads to comparable weight loss with fewer complications: a matched pair study. *Langenbecks Arch Surg.* 2016;401(3):307–13.
13. Schmid M, Folie P, Warschkow R, Steffen T. Long-Term Results of Linear Versus Circular Stapled Gastrojejunostomy in Gastric Bypass Surgery: A Propensity Score-Adjusted Analysis of Weight Loss and Morbidity. *Obes Surg.* 2025;35(6):2132–41.
14. Giordano S, Salminen P, Biancari F, Victorzon M. Linear stapler technique may be safer than circular in gastrojejunal anastomosis for laparoscopic Roux-en-Y gastric bypass: a meta-analysis of comparative studies. *Obes Surg.* 2011;21(12):1958–64.
15. Burla L, Weibel P, Baum C, Huber M, Gürtler T, Weber M. Linear versus Circular Stapler for Gastrojejunal Anastomosis in Laparoscopic Roux-En-Y Gastric Bypass: An Analysis of 211 Cases. *Surg Res Pract.* 2020;2020:4090797.
16. Edholm D. Systematic Review and Meta-analysis of Circular- and Linear-Stapled Gastro-jejunostomy in Laparoscopic Roux-en-Y Gastric Bypass. *Obes Surg.* 2019;29(6):1946–53.
17. Roemer N, Hauswirth F, Teuber H, Teuben M, Neff TA, Muller MK. Improved Clinical and Financial Outcomes in Proximal Gastric Bypass Surgery Following the Transition from a Conventional Circular Stapling to an Augmented Linear Stapling Protocol. *Obes Surg.* 2022;32(5):1601–9.
18. ICD-10-GM Version 2021, Systematisches Verzeichnis, Internationale statistische Klassifikation der Krankheiten und verwandter Gesundheitsprobleme, 10. Revision, Stand: 18. September 2020: Bundesinstitut für Arzneimittel und Medizinprodukte (BfArM) im Auftrag des Bundesministeriums für Gesundheit (BMG) unter Beteiligung der Arbeitsgruppe ICD des Kuratoriums für Fragen der Klassifikation im Gesundheitswesen (KKG); 2020 [Available from: www.bfarm.de – Kodiersysteme – Services - Downloads – ICD-10-GM – Version 2021.

19. Schweizerische Operationsklassifikation (CHOP), Systematisches Verzeichnis - Version 2025: Bundesamt für Statistik. 2024 [Available from: <https://www.bfs.admin.ch/bfs/de/home/statistiken/kataloge-datenbanken.assetdetail.32128591.html>]
20. Güller U, Warschkow R, Ackermann CJ, Schmied B, Cerny T, Ess S. Lower hospital volume is associated with higher mortality after oesophageal, gastric, pancreatic and rectal cancer resection. *Swiss Med Wkly*. 2017;147:w14473.
21. van Walraven C, Austin PC, Jennings A, Quan H, Forster AJ. A modification of the Elixhauser comorbidity measures into a point system for hospital death using administrative data. *Med Care*. 2009;47(6):626–33.
22. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40(5):373–83.
23. Obesity. preventing and managing the global epidemic. Report of a WHO consultation. *World Health Organ Tech Rep Ser*. 2000;894:i–xii.
24. Li Z, Wood SN. Faster model matrix crossproducts for large generalized linear models with discretized covariates. *Stat Comput*. 2020;30(1):1–7.
25. Long JS, Freese J. *Regression Models for Categorical Dependent Variables Using Stata*. 3rd ed. College Station, TX: Stata; 2014.
26. Mann HB. Nonparametric Tests Against Trend. *Econometrica*. 1945;13(3):245–59.
27. Kendall MG. A new measure of rank correlation. *Biometrika*. 1938;30(1–2):81–93.
28. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet*. 2007;370(9596):1453–7.
29. Edholm D, Sundbom M. Comparison between circular- and linear-stapled gastrojejunostomy in laparoscopic Roux-en-Y gastric bypass—a cohort from the Scandinavian Obesity Registry. *Surg Obes Relat Dis*. 2015;11(6):1233–6.
30. Finks JF, Carlin A, Share D, O'Reilly A, Fan Z, Birkmeyer J, et al. Effect of surgical techniques on clinical outcomes after laparoscopic gastric bypass—results from the Michigan Bariatric Surgery Collaborative. *Surg Obes Relat Dis*. 2011;7(3):284–9.
31. Jin T, Liu HD, Chen ZH, Hu JK, Yang K. Linear Stapler versus Circular Stapler for Patients Undergoing Anastomosis for Laparoscopic Gastric Surgery: A Meta-Analysis. *J Invest Surg*. 2022;35(7):1434–44.
32. Garcia Cabrera AT, Romero-Velez G, Pereira X, Vazzana JT, Camacho DR. Decreasing Surgical Site Infection Associated with the Use of Circular Staplers During Roux-En-Y Gastric Bypass. *Jsls*. 2022;26(4).
33. Sadiku F, Alceste D, Serra M, Hehl SJ, Gero D, Thalheimer A, et al. Comparative analysis of linear- and circular-stapled gastrojejunostomies in Roux-en-Y gastric bypass: a focus on postoperative morbidity using the comprehensive complication index. *Langenbecks Arch Surg*. 2024;409(1):120.

34. Berglund DD, Parker DM, Fluck M, Dove J, Falvo A, Horsley RD, et al. Impact of Urinary Catheterization on Postoperative Outcomes After Roux-En-Y Gastric Bypass Surgery in Propensity-Matched Cohorts. *Am Surg*. 2023;89(2):280–5.
35. Rothman KJ, Greenland S, Lash TL. *Modern epidemiology*. 3rd ed. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2008.
36. Lange UG, Mehdorn M, Dietrich A. [Anastomotic techniques in minimally invasive bariatric surgery]. *Chirurgie (Heidelb)*. 2023;94(9):768–74.
37. Chekan E, Whelan RL. Surgical stapling device-tissue interactions: what surgeons need to know to improve patient outcomes. *Med Devices (Auckl)*. 2014;7:305–18.
38. Lazzati A, Tresallet C, Guian G, Blanchard C. Investigating the trend of revisional bariatric surgery, the complications, and associated risk factors in France. *Int J Obes (Lond)*. 2026.
39. Brethauer SA, Kothari S, Sudan R, Williams B, English WJ, Brengman M, et al. Systematic review on reoperative bariatric surgery: American Society for Metabolic and Bariatric Surgery Revision Task Force. *Surg Obes Relat Dis*. 2014;10(5):952–72.

Figures

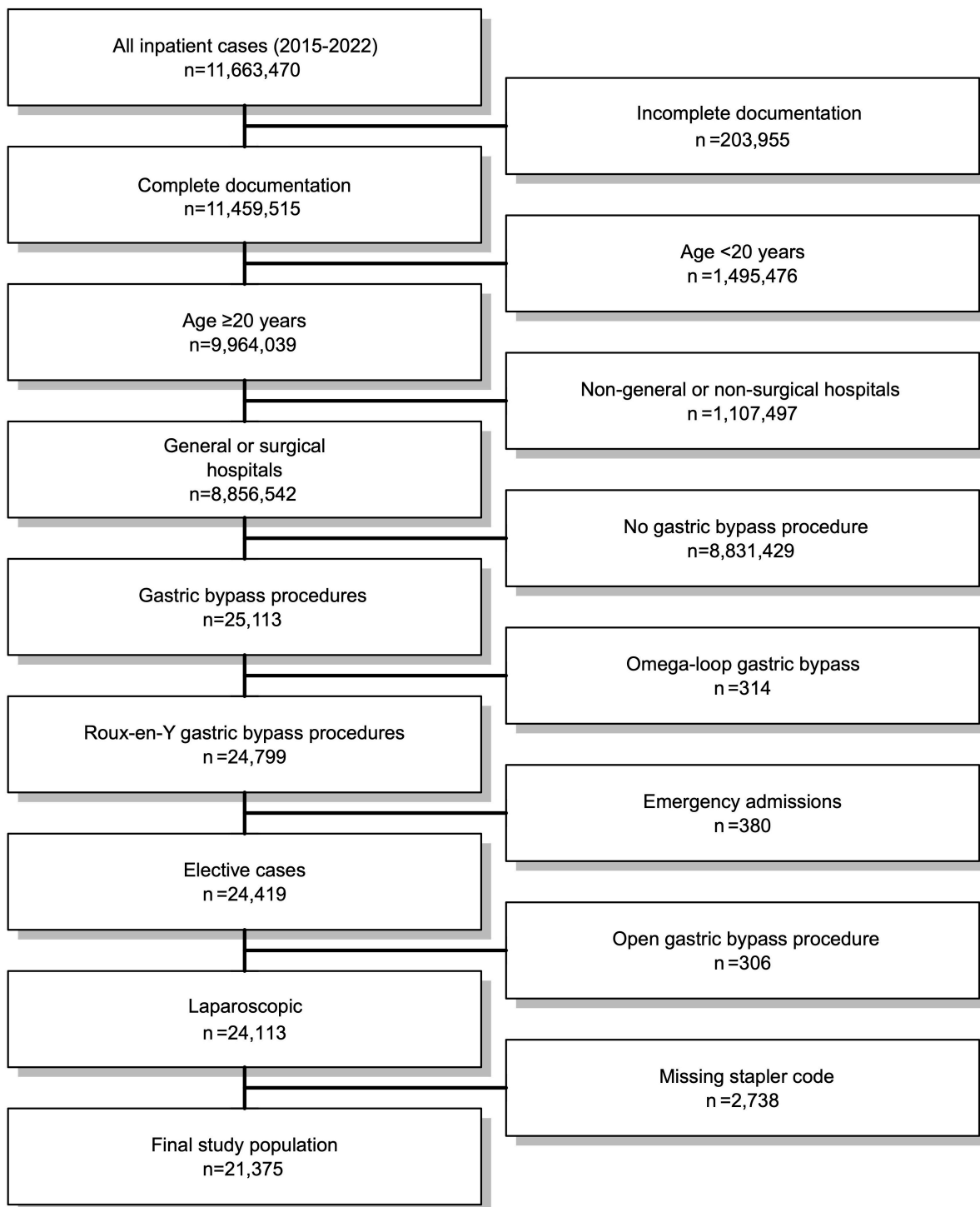


Figure 1

Case selection

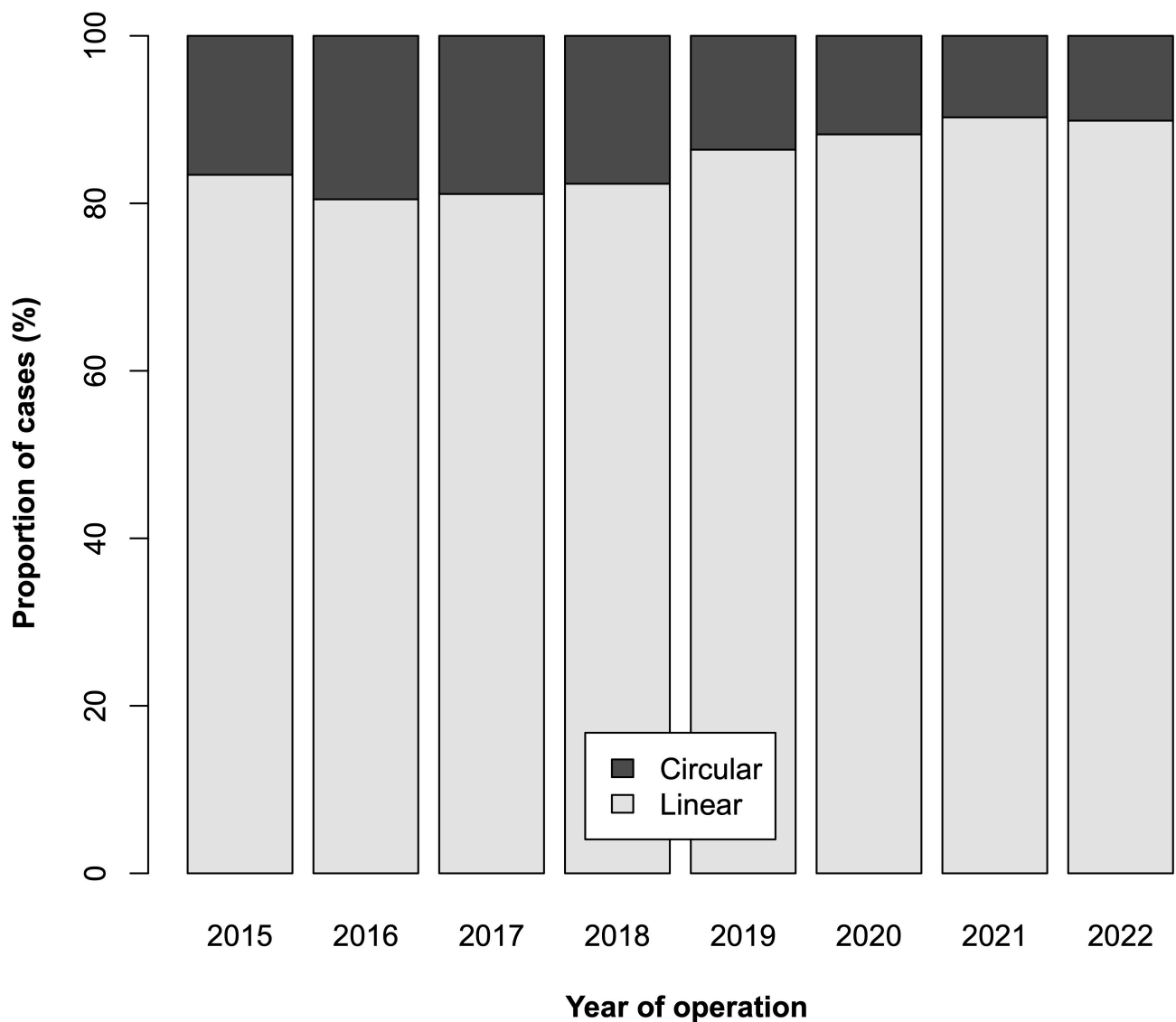


Figure 2

Annual use of linear (light grey) and circular (dark grey) stapling techniques between 2015 and 2022 in Switzerland. The proportion of circular stapling declined from 16.6% in 2015 to 10.1% in 2022 (Kendall's tau=-0.714, p=0.013)

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryMaterial.docx](#)